THE
ELECTRICAL REVIEW.

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CONTENTS:

	PAGE
The Disposal of House Refuse	405
The Electric Generating System of Prague (*illus.*) (*concluded*)	407
The Sulzer Exhibit at the Paris Exhibition (*illustrated*) ...	410
The Pacific Cable	411
The Paris Telegraph Fêtes (*illustrated*)	411
British Association for the Advancement of Science:—	
Abstract of Address to the Mathematical and Physical Section	413
The Disposal of House Refuse in Bradford	415
A Combination Integrating Wattmeter and Maximum Demand Indicator	418
Correspondence:—	
On the Nature of the Electric and Magnetic Quantities	419
The Doom of the Contractor	420
Guard Wires	420
Business Notes	420
Electrical Power Transmission in Smelting Works (*illustrated*)	421
Rathmines Electricity Works (*illustrated*)	426
Traffic Receipts	436
Stocks and Shares	436
Share List of Electrical Companies	437
Market Quotations	438
New Buildings of the St. Olave's Union, Ladywell (*illustrated*)	439
The Machinists' Strike in America	439
Steel: Its Properties and Tests.—II. (*illustrated*)	440
The Weir Water-Tube Boiler	440
The International Electrical Congress held at Paris, August 18th—25th, 1900	441
Reviews:—	441
Modern Electric Railway Motors	441
Mechanical Traction in War for Road Transport	441
Current Specifications.—XXVIII.	442
New Patents	443
Abstracts of Published Specifications	443

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1900

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THE DISPOSAL OF HOUSE REFUSE.

THIS all-important question has of late received a certain amount of attention, but not to the extent it deserves. At the British Association meeting this year Mr. John McTaggart contributed a valuable paper (which we reproduce almost *in extenso* in another column), on the subject of the disposal of house refuse at Bradford, but as Mr. McTaggart appears to have been the first to publish the results of a systematic trial of the performance of destructors extending over so long a period as a fortnight, it seems to us a fitting opportunity, while touching upon Mr. McTaggart's B.A. paper, to define the position we have always taken up and maintained with regard to the testing of destructor plants. We do this more particularly, as the effect of a recently-published note on the subject threatens to evoke a recrudescence of strong feeling on the part of consulting destructor engineers and manufacturing firms upon what they term our "pessimistic" attitude towards the destructor question.

A paragraph occurs in Mr. McTaggart's paper which may almost be taken as a summing up of our views, and we reproduce it here :—"As you will see, this test is a record of a complete fortnight's work, which in my opinion is the shortest period of time that a test of this nature should cover. Fictitious results may be obtained by some of the one, two, and up to 12 hours' tests usually shown by makers, as the stokers and other men employed may make a special effort for a few hours, which they would be unable to sustain during a two weeks' test. Then, again, if a 12 hours' test is made, say, in the middle of the week, it would be erroneous to assume that 12 times the quantity destroyed during that time would represent a complete week's work. There is always a period at the beginning and the end of a week when the rate of combustion is very low. Then, again, the nature of the refuse varies day by day. In fact, at one period of this test we were destroying refuse at the rate of 12 tons per cell per day."

We do not think that anything we can add to the above could more strongly emphasise the absurdity of short evaporative trials of destructor steam plants. We would, however, go further, and say that the quotient yielded by a division of the weight of water evaporated over a period of one year by the weight of refuse passed through the furnaces—provided always that combustion is completely effected, and that the gases issuing from the chimney are absolutely innocuous—would be a more trustworthy basis for the determination of the average evaporative power of the refuse in any one particular district.

Our position is simply this :—

1. We look upon the destructor, when properly installed, as the only solution of the problem connected with the sanitary disposal of the refuse of large towns.

2. We strongly deprecate the attempts which have been made from time to time to place a high value upon the

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calorific power of refuse by quoting the results of so-called tests which have been made under conditions that would not be accepted by impartial engineers conversant with, and experienced in, the methods essential to the obtaining of reliable average evaporative results.

3. We insist that the function of the destructor is to thoroughly and completely consume the refuse *as it is delivered by the collecting carts*, without any delay such as would be occasioned, for instance, by subjecting the refuse to any preliminary drying or other process. We also insist that such questions as the quality, quantity, and pressure of steam which may be raised by suitably combining a boiler with the products of combustion of the destructor furnace, and the uses to which such steam, or the heat of combustion of the refuse, *may* be put, should be considered of secondary importance; they should not be allowed to influence or interfere with the design of the destructor installation or the manner of its working, if this in any way prejudicially affects the proper function of the destructor as a means of disposing of the refuse of a town.

4. We quite admit that under certain favourable conditions the heat of combustion of refuse may be advantageously utilised for a variety of purposes, but we deprecate the attempted use of refuse as a fuel to raise steam for purposes which call for a regularity of evaporation and a constancy of pressure which can only be obtained by the use of good coal. When circumstances obtain in which it is not possible to maintain the efficiency of cremation at the same time as the constancy of pressure and the quantity of evaporation, it does not need a Solomon to decide which will go to the wall.

5. We always have, and we always shall, continue to use our best endeavours to expose the fallacy of any extravagant claims for the latent possibilities of refuse, and we shall always give prominence to honest endeavour to obtain satisfactory and reliable results as to the evaporative power of the refuse of any particular town or district, particularly when, as in the case of Mr. McTaggart's efforts, they are so clearly influenced by a genuine desire to get at the truth.

Replying to the discussion on his paper, Mr. McTaggart said that—

> In his opinion—and he had always recommended the Committee to adopt it—they should not try to have a duplicate plant at all. If they wished to have an electric lighting works, let them have one, and thoroughly up to date; if they wanted a destructor, let them have it as a destructor, and make that thoroughly up to date.

With this view we entirely concur, and we trust that our friends who have of late written and spoken so much of our "pessimistic" attitude will in future clearly appreciate our exact position.

Wireless Telegraphy in the recent Naval Manœuvres.

In the recent Naval Manœuvres, where the chief problem lay in the finding the whereabouts of either a friendly or hostile fleet which was expected to be somewhere in the vicinity, a more general application of Marconi's system would have been a great advantage. The friendly squadron was, in this case, divided, it will be remembered, one portion being at Lamlash in Scotland, and the other at Milford. The enemy's squadron was also similarly divided, one fleet being at Berehaven, and the other on its way up from Gibraltar. The chief aim of each Admiral was, of course, first to unite his two fleets, and then with his combined squadron to try and cut off the enemy before he could join forces. Very few of our cruisers are fitted with wireless telegraphic apparatus, and consequently the fog that prevailed upset all the plans of the cruisers for scouting operations, and even when it had cleared the distance at which flag signals could be made was very limited. Had each ship been fitted with wireless telegraphic apparatus, however, a line of cruisers could have been formed, through which it would have been almost impossible for the hostile fleet to effect a junction without their movements being known by the home squadron. As it turned out, however, the junction was effected without any difficulty whatever, and without the knowledge of the home cruisers. It appears that the French Navy has got ahead of us considerably in wireless telegraphy, being able to transmit messages through twice or three times the distance that Captain Jackson's adaptation of Marconi's system is capable of if all reports from Cherbourg are accurate. The French do not use a gaff attached to the mast upon which to hoist their wire, they suspend it upon the stay between the funnels. Doubtless, this is very convenient, but naturally it cannot be got to the same height as with a gaff.

Canal Navigation.—At the meeting of the Association of Chambers of Commerce in Paris on Friday last, says the *Standard*, Mr. Lee, of Bristol, moved, "That, having regard to the urgent necessity for utilising and improving the internal waterways of the United Kingdom, the President of the Board of Trade be requested to receive a deputation from this association with a view to the appointment of a Royal Commission to consider and report upon the whole question." Mr. Helm, of Manchester, in seconding, said that the importance of improving the inland waterways was recognised many years ago, and to-day the need was greater than ever. Sir Albert Rollit, M.P., in supporting the resolution, said he hoped it was not too late, though he knew it was very late in the day to save the life of the State canal system. The condition of the lower Thames, coupled with other reasons he was aware of, made it impossible for large vessels to come up the river. This was why London was ceasing to be the great entry port and centre of distribution which it had been. This question was one of most vital importance to English commercial men. They had heard that it was worth the while of the railways to acquire the canals, and shut them up, to remove competition. The public had better be on their guard with regard to the light railways. The railway companies were stimulating private applications. They would then acquire these railways, and perhaps deal with them in the same way that they had dealt with the canals. The debate was continued by several other speakers, and the resolution adopted.

It is a lamentable fact, that while numerous and well-directed efforts are constantly being made on the Continent to develop a thoroughly successful system of electric traction on the splendid waterways there existing, we in this country passively allow the railway companies to retain their throttling grip, like the Old Man of the Sea, on our canals. But few realise the enormous extent of these valuable waterways. Were they properly organised and made uniform in width and depth, with better lock accommodation, and freed from the repressive influence of the railway interests, an immense inland traffic could be carried upon them, with corresponding benefit to all classes, not least to agriculturists. Electrical haulage is already feasible, and is constantly becoming better adapted to this purpose. There is, however, ample scope for improvement, and the subject ought to be taken in hand by electrical engineers with a view to making it their own, as has been done in tramway work. As for the light railways, we are of opinion that Sir Albert Rollit's fears are quite unfounded

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made from time to time to place a high value upon the

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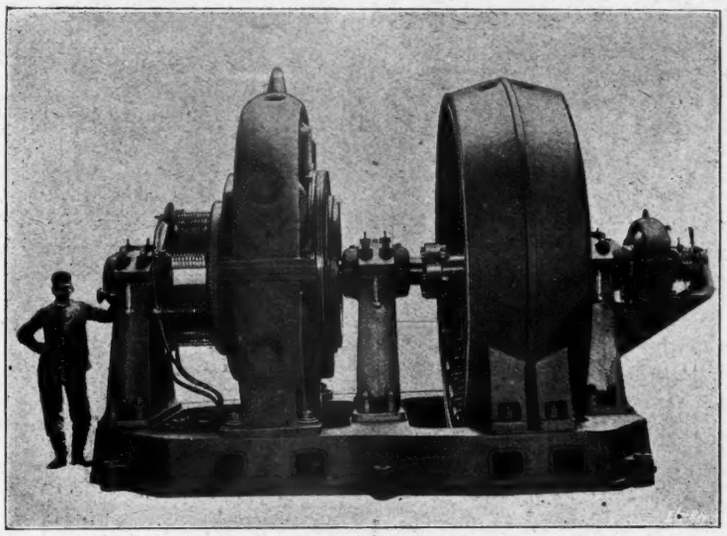
THE ELECTRIC GENERATING SYSTEM OF PRAGUE.

By FRED. BATHURST, A.M.I.E.E.

(*Concluded from page* 250.)

From the terminals of each generator the three high pressure leads are first taken to a "choking coil," whence lead-covered and armoured cables then conduct the 3,000-volt current to the switchboard. These choking coils are arranged below the engine room floor on small extensions of the dynamo foundations. They fulfil some very important functions.

In the first place, they prevent too large a rush of current if the current phases are not in exact coincidence when the alternators are being switched into parallel. They also prevent the "phase-swing" or "surging" of the alternators which may arise by reason of irregularity in the speed of the steam engines, or by the electrical resonance due to relative change of speed during one stroke of the engine. Further, they prevent "surging" occurring between the dynamos and the large synchronous motors of the sub-stations, a condition liable to occur when there is only a small load on the synchronous motors.

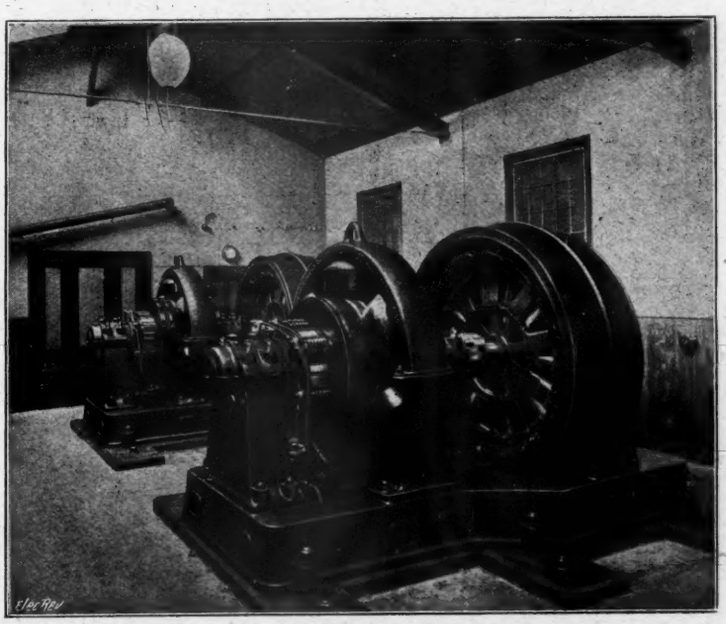


View of Motor-Generator Showing Exciter Mounting.

The choking coils resemble the Kolben Company's three-phase transformers, except that only one coil per core is provided, and that an adjustable air-gap of 8—10 millimetres is arranged between one of the straight yokes.

From experience gained with these choking coils it has been proved that they fulfil their purpose in every respect, and make it possible to supply from the same bus bars, current which can be used simultaneously for lighting and railway work with highly satisfactory results. Tests made at this station without the choking coils show that with the synchronous motors running free or only lightly loaded, a constantly-changing voltage up to 2 per cent. can occur with each stroke of the engines and a periodic surging up to 3 per cent. between the maximum and minimum of a longer surging period. It should be noted also that the "damping" influence of the choking coils is obtained with quite a negligible loss of energy, 800 watts apiece, or $\frac{1}{10}$th per cent. of the useful dynamo out-put. The drop caused in pressure is comparatively small, being 60 volts for full load, or about $3\frac{1}{2}$ per cent., for these large synchronous motors having proper excitation, work practically without any shifting of phase between pressure and current (that is with a power factor of $\cos\phi = \cdot 99$), as compared with a drop of some 12—15 per cent., which would be caused in the generators, if asynchronous motors, whose power factor cannot be larger than $\cos\phi = 0{\cdot}92$ were used. Under these conditions also, the cable network is not loaded with wattless currents which would considerably increase the drop in the cables.

The main switchboard is put upon a gallery in the central hall of the engine room. It is placed 18 feet above the floor level, so that the operators have a good view over the room, and is approached from either end by means of an iron staircase. It is entirely non-combustible, consisting of a main frame built up from angle steel upon which white marble slabs are mounted. The front or operating side only contains the well insulated levers of the switching mechanisms, and the few measuring instruments, whilst all the *live* switch parts, connections, safety fuses, transformers, regulating resistances, &c., are kept behind the board, and can only be reached by those who well recognise the danger possibility of high-pressure currents. Although the full board will have controlling capacity for 15,000 H.P., it contains at present the instruments required for the first five engine sets and the section necessary for synchronising the alternators.



Inside View of Sub-station.

The three main cables from each alternator lead through a three-pole H.T. switch, main fuse, ammeter, and wattmeter to the bus bars. The voltage of the exciters is regulated by means of shunt regulators to within $\frac{1}{2}$ per cent. of their working pressure. The steam engines, as already mentioned, are regulated by a $\frac{1}{4}$-H.P. three-phase motor placed upon each engine governor, this motor being worked by a small reversing switch on the board. The main, or station, voltmeter, with large dial, is placed above the centre of the board. The 3,000 volts of the generators is reduced on a small measuring transformer having a ratio of

The enemy's squadron was also similarly divided, one fleet being at Berehaven, and the other on its way up from

of opinion that Sir Albert Rollit's fears are quite unfounded

1 : 23·5, and measured on a hot-wire voltmeter for 127 volts.

The machines are switched into parallel in the usual manner by means of phase-indicating lamps, the bus bars being divided up by means of 57 switches into sections, which can be put in or out as required. When putting machines in parallel it is desirable to catch the engine cranks in the same position as each other, and to accomplish this acoustic signals are provided, the electric circuits of same being closed by the engines themselves. A feeder board containing four sections for the 16 feeders ultimately required is arranged behind the switchboard. Each feeder is provided with fuses and ammeters.

For the lighting of the station and surrounding buildings three transformers of 40, 20 and 10 KW. respectively are fed directly from the feeder bus bars. Two smaller steam dynamos of 400 H.P. each, generating direct current, are also placed in the station, in order to feed directly on to the feeders of the street railway system in the immediate neighbourhood of the station.

The Sub-distribution System.—The underground system of feeding cables brings the three-phase 3,000-volt current into the town to centrally-situated sub-stations. Here the alternating current is converted into 600-volt continuous current for railway and street lighting by means of motor-generators, or transformed down to low pressure to feed the light and power mains.

At present two motor-generator sub-stations are sufficient, one in place of the former temporary tramway station in the "Carlshof," and another on the "Kleinseite." That at the Carlshof has three motor-generators of the Kolben type; two run continuously, whilst the third is held as a reserve unit. There is room enough provided for two more units, as the enlarging demand may require. The motor-generator set consists of a three-phase synchronous motor, wound for 2,850 volts, coupled directly to a tramway generator of 450 KW. capacity and 600 volts pressure. Both machines are mounted upon a common bedplate, which has three bearings. Outside the motor side, supported by an extension bearing, and keyed directly on the mainshaft, a small (50-volt pressure) exciting machine is mounted, this exciter serving for the excitation of the synchronous motor, which has 24 poles, and at 48 periods per second, makes 240 revolutions per minute. The magnet wheel of the three-phase motor is the rotor, and is cast as one piece of cast-steel, with the laminated pole-pieces in position. The stator-armature forms the outside frame, the high pressure windings being placed in the slots of the laminated armature ring. The excitation required at full load is 3,800 watts (50 volts × 70 amperes), or less than 1 per cent. of the useful output.

The tramway generator is an eight-polar machine, with cast-steel field magnet frame, and a slotted drum-wound armature with parallel winding. It is designed for an output of 820 amperes at 550 volts, or 750 amperes at 600 volts, the current being taken off the commutator by eight sets of carbon brushes, and their position is not altered for load variations.

Two switchboards are provided in the Carlshof sub-station, one being for the motor-generators and the set of accumulators (Puffer system) working in connection with them, and the other for the connections of the feeding cables supplying the railway and lighting systems.

The main switchboard is of fireproof construction, on the same lines as the generating station board already described, and, like it, has two distinct divisions for the primary and secondary sections. Two primary feeders of 3 × 100 square millimetres copper area bring the current at 2,850 volts on to the board, and it then passes through switches, measuring instruments, and fuses to the motor-generator sets.

The 600-volt generators are connected in parallel to the secondary bus bars through minimum automatic cut-outs, which come into action when the generator voltage drops below that of the accumulators.

The storage battery has a capacity of 518 ampere-hours for one hour's discharge, and consists of 276 Tudor cells. It has proved a most useful adjunct to the sub-station equipment, as it automatically takes up the quick and short overloads occurring on the line, and relieves the necessity for hand regulation of the generators. A 20-division cell regulator switch is provided on the switchboard, 100 of the cells being utilised for adjustments in sets of five each. About once a week, and during that part of the night when the tramcars are not running, the whole battery is overcharged; for this purpose a special connecting switch is arranged on the switchboard so that the battery can be divided up into halves, and for four or five hours the charging and overcharging is effected by the railway generator of the motor-generator set running at a maximum pressure of 360 volts only and 2 × 400 amperes.

This ingenious arrangement, it will be noted, entirely dispenses with a booster dynamo, and allows the cells to be kept in thoroughly efficient and fully charged condition.

The starting up of these sub-stations is most easily effected. The synchronous motor is first started by the tramway generator being run as a motor, either from the tramway system bus bars, or from the accumulator set itself, a small starting resistance box being provided for this purpose. When the proper speed of the set (240 revolutions) is nearly obtained, the synchronous motor is excited from the direct coupled exciter. Then, by means of the shunt regulator of the tramway dynamo, its speed (running as a shunt motor) is properly adjusted to exact synchronism, as indicated by the lamp indicator and the synchronous motor part switched in. The dynamo part is then fully loaded by the simple adjustment of the shunt regulator. The whole operation takes but a minute or two, and no difficulty or confusion is experienced.

The second tramway sub-station, "Kleinseite," is on the left side of the Moldan river, and supplies current for the tramway and public arc lighting service in its immediate neighbourhood. It contains at present two motor-generator groups of 180 KW. secondary output each. Their arrangement and design is quite similar to those already described. The accumulator here consists of 276 cells of 296 ampere-hours capacity at one hour's discharge.

The Cable Network fulfils several distinct functions; one part transmits the high pressure three-phase currents from the main generating station in Holeshoric to the various sub-stations and distributing points. Then there is the low pressure secondary distribution system for incandescent lighting and power circuits, and the separate feeder systems at 600 volts pressure for tramway and public arc lighting. Eight high pressure cables leave the main station, two of 3 × 50 square mm. section run a distance of 3½ kilometres to Kleinseite for the left side of the town; six of 3 × 1,000 square mm. run to the centre of the main part of the town to a distributing point on the Josefplatz. From here four of them connect to four main feeder points on the high pressure distributing system, whilst two run to the outlying distributing point, Karloo, which is 5¼ kilometres distant from the main station Holeshoric. The main cable connection boards at the various points are usually placed below the floors of the waiting rooms provided for the electric railway. From these feeding or equalising points the primary H.T. system branches off as closed rings through the main thoroughfares, and forms a basis for the secondary ring system, for lighting and motors, fed at 43 transformer stations, which are either in the form of underground pits, or the familiar Continental auziger or advertising column resembling an enlarged pillar letter-box.

These transformer stations usually contain from two to five transformers of 20—50 KW. output each. The secondary distribution in the low pressure ring being at 123 volts between each of the three conductors, connections are taken directly to the houses of the consumers either for lighting or motors. Lead-covered armoured cables are mostly employed (Felten & Guilleaume's manufacture), and, as usual in Continental practice, the trenches are partly filled with sand, the cables laid in, and a layer of bricks placed over all for mechanical protection before the earth is filled in.

The feeding points for the trolley wires are arranged in the bases of the iron supporting posts, each line section being fed by a special feeder, which can be disconnected when desired.

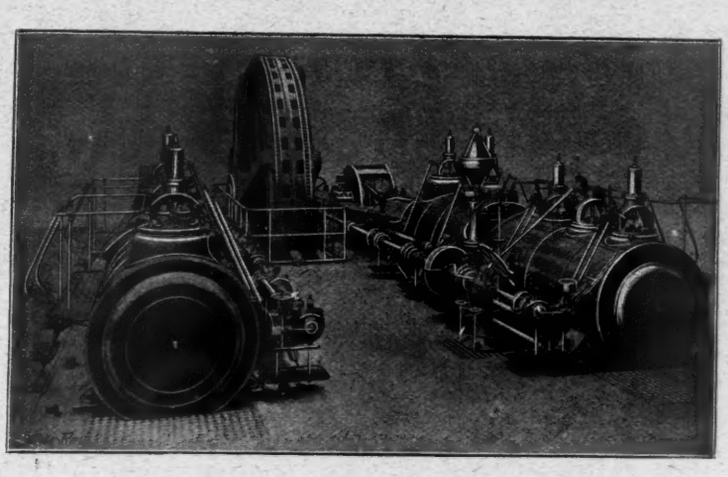
The distribution for the public arc lighting is effected at 600 volts by cables fed with continuous current from the tramway sub-stations.

There are 150 arc lamps arranged in series sets of 10

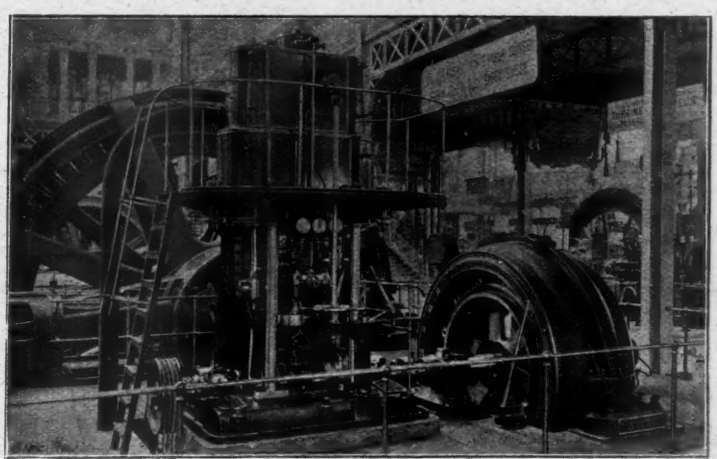
coils is obtained with quite a negligible loss of energy, on a small measuring transformer having a ratio of

each. Every two sets are interlinked and fed from different points, so that there is but little risk of any total interruption of the lighting. By the adoption of 600 volts continuous current for the arc lighting, the feeders required at night for the lighting supply can in the day time be utilised for the tramway supply, and thus reduce the drop considerably during the heavy daily load, which is mainly street car service. For instance, with a load of 900-KW. on the "Karloo" and 180-KW. on the "Kleinseite" sub-stations, the actual drop on the feeder system is only 6 per cent. and 1½ per cent. respectively.

When the generating station was first designed, it was difficult to decide which of the four fields for the consumption of the supply (railway, arc lights, incandescent lamps, or motors) would be the largest, each apparently having unlimited possibilities. This consideration led to the adoption of a system that could be equally applicable to all developments. The distances and area to be covered precluded continuous current apparatus and decided for some form of alternating current distribution. For a lighting supply a minimum of 48 periods had to be decided upon. As regards sub-station supply, three systems were open to choice, namely, by rotary converters, motor-generators with asynchronous motors, or motor-generators with synchronous motors. The design of rotary converters of 700 H.P. capacity and 48 periods is recognised as extremely difficult. For such large units a speed of 250—300 revolutions per minute cannot be exceeded on account of the limited radiating surface of the armatures and their heating limit. There is the further difficulty of taking off current by carbon brushes at such high commutator surface speed. Again, static transformers of 500 KW. output would present difficulties of heating, for the ordinary form having insufficient natural radiating surface, they would involve special air or oil cooling arrangements with every group. These considerations, therefore, favoured the use of motor generators.



THE SULZER EXHIBIT AT THE PARIS EXHIBITION.—FIG. 1.



THE SULZER EXHIBIT AT THE PARIS EXHIBITION.—FIG. 2.

The choice between synchronous or asynchronous motors depended upon such points as the better power factor, the stability of running, the ability for carrying overload, and the influence of the motor in case of load variation upon the network. The former type was chosen, for with proper excitation $\cos \phi$ can be made nearly equal to 1, the asynchronous motor having in the best case a power factor not exceeding ·91 at full load and considerably less on underload. In the present case practical results have also shown that large synchronous motors, working in parallel with a secondary battery, are not only capable of running steadily under full load, but they also stand up against heavy overloads—not a single stoppage having been caused by reason of sudden overload during the six months they have been in operation.

These synchronous motors do not require more attention than the asynchronous, for being well designed, their most economical excitation is nearly constant for all loads, and regulation is not required.

The only possibility that has presented any difficulty is that of the "surging" already referred to, but this has been successfully overcome, and without serious waste of energy, by the proper use of choking coils, and the credit for this successful innovation is due to Mr. Emil Kolben.

We have therefore at Prague an extremely simple service of electrical energy, suitable for all purposes, and furnished from one set of bus bars. Its application has already been proved on an exceptionally large scale, and it is no little compliment to the resources of Bohemian electrical firms to find that the whole of the electrical and mechanical equipment of this pioneer station has been furnished exclusively by local houses.

The writer is indebted to Mr. Emil Kolben for the information given above (the local firm of Kolben & Co. having designed and carried out the whole of the electrical part of the central and sub-stations), and, in conclusion, cannot do better than reiterate the main principles upon which it was designed.

1. The employment of a closed primary and secondary distribution cable system, with transformer stations of large capacity, the cables being designed for small drop, and the transformers with close regulation.

2. The employment of large accumulator batteries for the electric tramway service, in order to balance large load variations, and keep a nearly constant load upon the motor generators.

3. The design of three-phase generating alternators with small drop between no load and full load, so that small differences in the loads of the three phases causes no appreciable difference of pressure in the branch circuits, the alternators being driven by engines of very close speed regulation.

4. The service of electric tramways by sufficiently large synchronous motor-generators which are assured against surging by some efficient damping or choking arrangement.

THE SULZER EXHIBIT AT THE PARIS EXHIBITION.

We have pleasure in giving our readers some views of the magnificent specimens of engine workmanship which Gebruder Sulzer are exhibiting. Fig. 1 is a four-cylinder triple expansion engine of 1,700 I.H.P., of which the following are the principal dimensions:—

Diameter of high pressure cylinder	...	600 mm.
„ mean „	...	850 „
„ low „	...	1,025 „
Stroke	...	1,500 „
Revolutions per minute	...	85 „
Steam pressure	...	11 atmospheres.

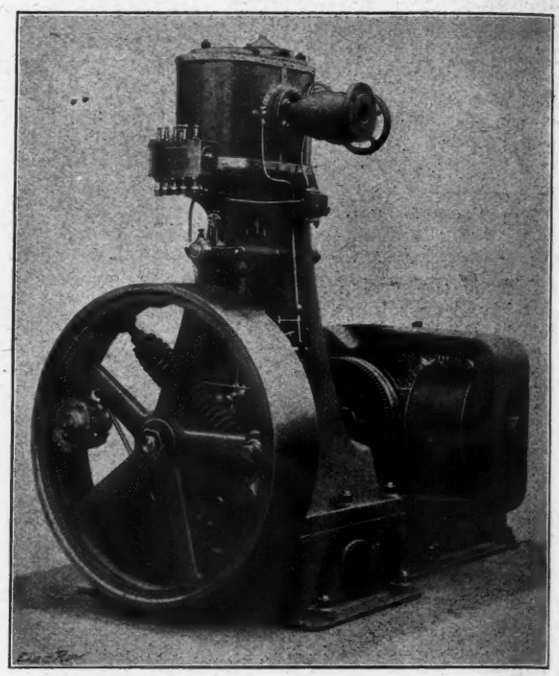
With the normal 30 per cent. cut-off in high pressure cylinder, the power developed is 1,700 indicated or 1,500 effective, and with 40 per cent. cut-off, the engine will give 1,950 I.H.P., or 1,750 effective. The two low pressure cylinders are nearest the crankshaft, this construction being adopted with a view to keeping the cross-head as cool as possible. The engine is employed in driving the Brown-Boveri three-phase alternator, which was described in our issue of June 29th, page 1083.

On the left hand of fig. 4 is a tandem compound single-crank engine, coupled to a three-phase alternator by J. J. Rieter & Co. The dimensions are:—

Diameter of high pressure cylinder	...	525 mm.
„ low „	...	875 „
Stroke	...	1,100 „
Revolutions per minute	...	100
Steam pressure	...	11 atmospheres.

With the normal 23 per cent. cut-off, the engine gives 750 I.H.P., or 650 effective, and with 40 per cent. cut-off 1,000 indicated and 900 effective. This engine has an exceptionally massive fly-wheel overhung on the side away from the crank, so as to carry the alternator poles on the inner periphery of the rim. This construction is specially suitable where the engine has only a single crank, because it is possible to put very great weight into the fly-wheel without in any way interfering with the electrical design of the alternator.

Fig. 2 shows a 385 I.H.P. vertical double compound engine driving an Oerlikon Company's alternator. The engine has two high pressure cylinders, each 280 mm. diameter, and two low pressures 450 mm., the stroke being



The Sulzer Exhibit at the Paris Exhibition.—Fig. 3.

The Sulzer Exhibit at the Paris Exhibition.—Fig. 4.

400 mm., and speed 250 revolutions per minute. The cranks are at 180°, and the valves are cylindrical, the steam admission and exhaust being obtained by a rotary movement. It will be noticed that the governor is between the two connecting rods, being driven by bevel gearing from the crankshaft. This set is used for the illuminations round the outer *façade* of the Champ de Mars buildings.

Fig. 3 is a 30-H.P. vertical engine with fly-wheel governor, and fig. 4 is a view of the complete exhibit.

THE PACIFIC CABLE.

The specification for the proposed Pacific cable is divided into three sections. The first is that of the Vancouver (Port San Juan)—Fanning Island cable, which has a total length of 3,653·5 nautical miles, all of this being main cable with the exception of 64½ nautical miles of heavy shore end, heavy intermediate an dlight intermediate. The conductor will be composed of a central copper wire surrounded by smaller ones, weighing altogether 600 lbs. per nautical mile, and having a resistance of not more than 2·03 B.A. ohms at a temperature of 75° F. It is to be insulated with three or more coatings of gutta-percha weighing 340 lbs. per nautical mile.

The dielectric, after 1 minute's electrification, is not to have a resistance of less than 500, nor more than 1,500 megohms per nautical mile at 75° F., and its average inductive capacity is not to exceed 0·440 microfarad per nautical mile. The shore end and intermediate core is to be sheathed with brass tape, but the core for the main cable is not so protected.

The second contract is for the Fanning Island—Fiji (Suva), length totalling 2,181 nautical miles, composed of 8 miles heavy shore end, heavy intermediate and light intermediate; 649 miles of heavy deep sea, and 1,524 miles of light deep sea cable.

The conductor weighs 220 lbs. per nautical mile, and is composed of a central copper wire surrounded by smaller ones, having a resistance at the usual temperature adopted in cable testing of not more than 5·54 B.A. ohms.

The gutta-percha covering weighs 180 lbs. per mile, insulation resistance as in the previous case, with an inductive capacity not exceeding 0·385 microfarad per mile. The short lengths are brass sheathed as before.

The third contract comprises the following sections :—(*a*) Fiji (Suva)—Norfolk Island (Sydney Bay); (*b*) Norfolk Island (Sydney Bay)—Queensland (Moreton Bay); (*c*) Norfolk Island (Sydney Bay)—New Zealand.

(*a*) has a total length of 1,019 miles, all but 50 being deep sea. (*b*) a length of 906 miles, of which 852 miles are deep sea. (*c*) 513 miles, 440 being deep sea, the grand total under this contract amounting to 2,438 nautical miles.

The core of all three sections is 130 lbs. copper and 130 lbs. gutta-percha per mile, the conductor consisting of a strand of seven copper wires. The insulation resistance is to be as in the two previous contracts, and the inductive capacity shall not exceed 0·355 microfarad. We do not think it necessary to devote space to discussing the outer coverings or outer servings of these cores, but one of the tests to which the core may be subjected, affords an opportunity for comment.

So far as our calculations go, we find that the thicknesses of the gutta-percha in contracts 1, 2, and 3, are approximately 125, 100, and 90 mils. respectively. In contract No. 1, we observe that "each coil of core shall, if required, be submitted to an alternate E.M.F. of at least 5,000 volts, this electrical pressure to last 15 minutes on each coil." Contract 2 is subject to the same conditions, as is presumably contract 3, but in this the clause reads "each coil of core shall, if required, be submitted to an alternative current (*sic*) of at least 5,000 volts, &c." Probably both expressions are intended to have the same meaning, but to say the least, the phraseology is loose.

There is no mention of periodicity or of the form of apparatus to be employed to produce the high voltage, and it is conceivable that appliances might be constructed to give the voltage demanded which should have no effect on the core at all. Tesla employed alternating current apparatus for his high tension experiments in which millions of volts were concerned, with Tesla himself forming part of the circuit.

But, in our opinion, it is unnecessary and hazardous to subject submarine cable core to such excessive pressures, and we cannot help thinking that there must be a risk of creating weak places in the dielectric due to the strain.

We are aware that this is not the first specification in which this clause has appeared, so that it has already been accepted by some contractors, and it was, we believe, originated by a firm of submarine cable makers, who themselves specified for this particular test on more than one Atlantic cable made by them. Indeed, we have been informed that this firm has gone so far as using 10,000 volts alternating, with a frequency of about 200.

This may possibly have been a bold stroke of policy in the belief that no other manufacturers would dare to go so far, for it is not so many years ago that contractors would have been very loth to use a testing battery, of even 1,000 cells, upon submarine core; and, as we have suggested, it certainly could be done by others under special conditions, which, however, would have no real value as a means of proving that the material employed is of the best description and manufacture.

No doubt the clause will be accepted by those who tender, and we can imagine them feeling that if it gives peace to the minds of those who are to pay for the luxury, why should contractors grumble?

Possibly the core will stand 5,000 alternating volts if the frequency is sufficiently high, but "an alternative current of at least 5,000 volts" is quite a different thing, depend upon it!

But why was not the voltage made proportional, or at least made to bear some relation to, the thickness of the insulator?

If 5,000 volts is well within the maximum which the thinnest of the specified coatings of dielectric will bear, why was not the pressure increased for the next thickness, and still further for the thickest? If, on the other hand, 5,000 volts is considered enough for the 125 mils, it is too much for the core of 90 mils.

Fortunately, however, the words "if required" may lead to this wholly unnecessary strain on the core being eliminated from the usual tests, more especially when we read that "for the purpose of testing the laid cable, the engineer shall be at liberty, as long as the cable remains in good electrical condition, to use a battery power equivalent to 100 volts."

Fancy any material other than that of a submarine cable being subjected to an overload 50 times greater than it will have to bear in practice, an overload, too, accentuated in this case, because alternating voltages in practice are employed for breaking down faults!

THE PARIS TELEGRAPH FÊTES.

[FROM OUR SPECIAL CORRESPONDENT.]

(Third Letter.)

Paris, *August 26th*, 1900.

Our last letter brought the proceedings down to Wednesday evening. On Thursday morning the visits to the larger offices of the administration were commenced. From 9 a.m. to noon a continuous stream of visitors passed through the central telegraph office situate at 103, Rue de Grenelle. The visitors were conducted round in groups of about 20. Our course lay first through the engine room where we were shown the four large Belleville boilers which are used for the supply of the power for working and lighting the building. There are four very fine dynamos by Sautter Harlé & Cie., of Paris. The switches and ampere-meters are by Richard Bros., of Paris. We then visited the battery room, which at one time contained 11,000 cells which have now been replaced by the more compact and manageable accumulators. There are four sets of accumulators of 60 cells for each set. Each set is capable of supplying the entire power necessary for working the lines. The arrangements are so made that two sets are used alternatively in ordinary practice and two sets are kept in reserve in case of a breakdown.

In the galleries our course first lay through the foreign department. With the exception of one line working to Christiania, the work is done entirely by means of typewriting apparatus. The Baudot is the more common type, but the Hughes has a large share in the arrangements. The

most remarkable installation of the Baudot is that which is working to Milan. A quadruple set is worked between Paris Central and Milan Central. At each extremity two of the arms are so altered as to form repeaters and the line is extended to Paris Bourse in the one case and Milan Bourse in the other. At each Bourse a second distributor of the type used for duplex installations is used. Thus, by this system it is possible by using only one trunk line to give two circuits to each central office, and two circuits to each Bourse. The output of each of these circuits is stated to be an average of 80 messages per hour, which is sufficient to cover the work exchanged during the busiest parts of the day.

The Christiania wire is supplied with Wheatstone apparatus manufactured by the firm of Siemens Brothers, and is of precisely the same type as that used in the British Post Office. The speed of working at the time of our visit was about 60 words per minute, and we were assured that this was about the normal. The speed and quality of the work seems to be much impaired by the very inferior quality of the paper employed for transmitting ribbons. On examination it proved to be limp and greasy, and compared very unfavourably with the firm dry ribbons used in the British Post office. The French paper would be utterly useless for the purpose of multiple transmissions, as one passage through the transmitter left it crumpled and damaged. The French staff seem to know and appreciate the superiority of the English paper which has been on trial in Paris.

From the foreign *salle* we passed into the provincial annexe. 80 per cent. of the wires are worked with the Baudot, the remainder employing the Hughes. A Hughes apparatus is held in reserve for each Baudot set in case of a breakdown. All the apparatus is driven by electric motors, the weight-driven apparatus having entirely disappeared.

The chief of the provincial *salle* gave us some interesting information concerning the staff. The female staff exceeds by a small number the male staff. There are two brigades of men numbering 290 for each brigade, or a total of 580. The normal female staff numbers 293 for each brigade, or a total of 586. On account of the increased work due to the Exhibition a considerable number of females have been drawn from the sub-offices and the provinces, and the present female staff numbers 660. At the end of the season this temporary staff will return to its former quarters.

The duties are arranged to cover the hours from 7 a.m. to 9 p.m., and each clerk performs seven hours per day. Thus No. 1 brigade will come on the first day for what is known as the *petit service* from 7 a.m. to 9.30 a.m. for females, and 7 a.m. to 10 a.m. for males. The same brigade returns to duty at 4.30 p.m. until 9 p.m. for females, and 5 p.m. to 9 p.m. for males. No. 2 brigade performs on the same day, what is known as the *grand service*. This is for females 9.30 a.m. to 4.30 p.m., and for males from 10 a.m. to 5 p.m. On the following day the two brigades reverse the order of the duties, and so they alternate throughout the year. Night duties are provided for in the following way:—About once each fortnight it comes to the turn of a member of the male staff to perform night duty. At the end of his *petit service* at 9 p.m. he remains on duty until 7 a.m. the following morning, receiving in recognition of this service payment at the fixed rate of 1 franc per hour. In addition to this payment he is released from duty for the *grand service* of seven continuous hours on the following day. Sunday duty is a part of the ordinary duty, and is not paid as an extra, but according to the exigencies of the service, a number of the staff are liberated. At the Bourse office each member of the staff is free on alternate Sundays. At the central one Sunday in four is about the rule, whilst in many offices the work never permits of a free day.

From the first provincial *salle*, we were conducted to the Morse room. The Morse writer is here being gradually replaced by the sounder. The type of instrument is the "pony" sounder of the same pattern as is in use in the

M. Dubois, Secrétaire.
M. V. de Lirac, Secrétaire Général.
M. Mio, Directeur des Postes de la Seine.
M. Ansault, Directeur de l'Exploitation Postale.
M. Frouin, Directeur des Services Electriques.
M. Amiot, Vice-Président de l'Association Amicale.
M. Ecarnot, Trésorier.
M. Bezanson, Secrétaire.
M. Charvin, Chef du Bureau Central des Téléphones.
Vice-Président, M. de Pydemarc, Directeur des Bureaux Ambulants.
Président, M. Vivier, Inspecteur.
Vice-Président, M. Meyrat, Inspecteur.
M. Constant, Inspecteur.
M. Sabourain, Inspecteur.

The Organising Committee of the Post and Telegraph Fetes, Paris, 1900.

British Post Office with keys of the single current type. The most remarkable feature of the installation is the entire absence of local circuits. Even on the longer wires the sounders are worked by a direct current. From our personal observation we feel that the result is that the marks are not so clear or firm and the working is considerably slower. The latter fact is due in part perhaps to the more leisurely method of working of the Continental telegraphist, but also mainly to the nature of the signals. The whole of the messages are written in ink which also reduces the speed.

On the lines of lesser importance a switch system, resembling in its principal features the Umschalter switch of the British Post Office, is employed. The French system is known as the Mandroux, and seems to be a very complete system, although it did not for many reasons appear to result in so considerable an economy of staff as is effected by the British system.

From the Morse *salle* we were conducted to the upper *salle* which works by Hughes apparatus to a few provincial centres, but which for the most part is occupied by spare sets of Hughes apparatus for use in case of emergency. The most commendable feature in the installation was the foresight of the organisers.

Unlike our own "hand-to-mouth" method of preparation for minimum requirements, the French Administration have made preparation for emergencies and breakdowns in each department. The accumulator room has practically three spare sets, the instrument galleries contain spare space and spare apparatus, and the staff is well above the minimum requirements of the work. Some day the lessons of postal and telegraph breakdowns in England may engender a like commendable provision for emergencies. But we move slowly.

After our visit to the central office a number of group photographs were taken in the courtyard, and the delegates then separated until the evening, for which an invitation had been issued to attend a performance at the newly-erected Hippodrome. A most admirable equestrian display was here witnessed, which concluded by a ballet and spectacle representing the early history of France and the Roman invasion. The whole was concluded by a series of tableaux representing the military history of France, which evoked a storm of well-earned applause.

On Friday morning we visited the Recette Principale or General Post Office in the Rue des Louvre, but were unfortunately too late to see the Central Telephone Office. What struck us particularly at the General Post Office was the very complete way in which all possible emergencies were foreseen. The staff and the space were equal to the maximum requirements of the work. The most perfect order and discipline seemed to be maintained.

Saturday was a comparatively free day. Visits were paid to the Exhibition and its grounds. In the evening a very sumptuous dinner was offered to the delegates in the American Restaurant in the Champ de Mars. The company was vast in its proportions. Nearly one thousand persons sat down. The weather was close, but as the dinner was taken practically in the open air, no inconvenience was felt. The company was most distinguished, and the number of decorations worn was surprising to the English eye. The Minister of Posts and Telegraphs (M. Millerand) was absent, owing to the illness of his little son, and M. Mongeot, the Under Secretary of State, excused himself on account of his recent bereavement. In their absence the chair was taken by M. Ansault, the effective president of the organising committee. In an excellent speech M. Ansault expressed his delight and satisfaction at seeing so many distinguished representatives of foreign countries around him, and also so many high officials of the French administration. He assured the company that France was proud to have assembled under her flag so representative a gathering of those engaged in the binding work of commerce. Postal organisation represented the arteries of civilisation, and the Exhibition of Paris was a fitting place for the reunion of the organisers. The Exhibition claimed to be the apotheosis of the commerce and industry of the age, and so it was most fitting that those so intimately engaged in facilitating the international commerce of the world should meet there to fraternise and to exchange views. Colonel Frey, the director of the Internationale Bureau of Telegraphs, replied on behalf of the foreign delegates in a most happily conceived and well-delivered speech. M. de Lirac, the general secretary of the organising committee, also delivered a most witty and clever speech in reply to the toast of "The Organising Committee"—a speech which elicited a salvo of applause. The delegates then dispersed to view the illuminations and other attractions of the Exhibition.

On Sunday, the secretary, M. de Lirac, and M. Amiot, the vice-president of the "Amicale" Society, and a member of the organising committee, gave a *dejeuner* to their personal friends and colleagues of the various delegations at the Restaurant "La Petite Chaise," in the Rue de Grenelle. Among those present were MM. Réné Olivier, of Nice, C. H. Garland, of London, W. Huisman, junr., of Almelos, Holland, editor of the *Post-en-Telegraafwereld*, Signorina Rizzioli, of Milan, and several others. Afterwards short speeches of thanks and congratulations were exchanged, and the last and not least pleasant of the many charming functions was brought to a close.

A special medal is being struck at the National Mint, a copy of which in bronze will be given to each delegate, and a gold copy to each member of the organising committee. The medal bears on its obverse side an inscription "Post and Telegraph Fêtes, Paris, 1900," and a scroll bearing the name of the delegate. On the reverse is a beautiful female head wearing a floral wreath and the inscription "Republique Française."

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRADFORD, 1900.

ABSTRACT OF ADDRESS TO THE MATHEMATICAL AND PHYSICAL SECTION.

By Joseph Larmor, M.A., D.Sc., F.R.S., Pres.C.P.S.,

President of the Section.

It is fitting that before entering upon the business of the section we should pause to take note of the losses which our department of science has recently sustained. The fame of Bertrand was long ago universally established; the debt which we owe to that other veteran, G. Wiedemann, both on account of his own researches and for his great and indispensable thesaurus of the science of electricity, cannot easily be overstated. In our own country we have lost in D. E. Hughes one of the great scientific inventors of the age; while we specially deplore the removal, in his early prime, of one who has recently been well known at these meetings, Thomas Preston, whose experimental investigations on the relations between magnetism and light, combined with his great powers of lucid exposition, marked out for him a brilliant future.

Perhaps the most important event of general scientific interest during the past year has been the definite undertaking of the great task of the international co-ordination of scientific literature.

The usual conferences connected with our department of scientific activity have been this year notably augmented by the very successful international congresses of mathematicians and of physicists which met a few weeks ago in Paris.

The recent reconstruction of the University of London, and the foundation of the University of Birmingham, will, it is to be hoped, give greater freedom to the work of our University Colleges. The system of examinations has formed an admirable stimulus to the effective acquisition of that general knowledge which is a necessary part of all education. So long as the examiner recognises that his function is a responsible and influential one, which is to be taken seriously from the point of view of moulding the teaching in places where external guidance is helpful, test by examination will remain a most valuable means of extending the area of higher education. Except for workers in rapidly progressive branches of technical science, a broad education seems better adapted to the purposes of life than special training over a narrow range; and it is difficult to see how a reasonably elastic examination test can be considered as a hardship. But the case is changed when preparation for a specialised scientific profession, or mastery of the lines of attack in an unsolved problem, is the object. The general education has then been presumably finished; in expanding departments of knowledge, variety rather than uniformity of training should be the aim, and the genius of a great teacher should be allowed free play without external trammels. It would appear that in this country we have recently been liable to unduly mix up two methods. We have been starting students on the special and lengthy, though very instructive, processes which are known as original research at an age when their time would be more profitably employed in rapidly acquiring a broad basis of knowledge. As a result, we have been extending the examination test from the general knowledge to which it is admirably suited into the specialised activity which is best left to the stimulus of personal interest. Informal contact with competent advisers, themselves imbued with the scientific spirit, who can point the way towards direct appreciation of the

works of the masters of the science, is far more effective than detailed instruction at second hand, as regards growing subjects that have not yet taken on an authoritative form of exposition. Fortunately, there seems to be now no lack of such teachers to meet the requirements of the technical colleges that are being established throughout the country.

The famous treatise which opened the modern era by treating magnetism and electricity on a scientific basis appeared just 300 years ago. The author, William Gilbert, M.D., of Colchester, passed from the Grammar School of his native town to St. John's College, Cambridge; soon after taking his first degree, in 1560, he became a Fellow of the College, and seems to have remained in residence and taken part in its affairs, for about 10 years. All through his subsequent career, both at Colchester and afterwards at London, where he attained the highest position in his profession, he was an exact and diligent explorer, first of chemical and then of magnetic and electric phenomena. In the words of the historian Hallam, writing in 1839, "in his Latin treatise on the magnet, he not only collected all the knowledge which others had possessed, but he became at once the father of experimental philosophy in this island;" and no demur would be raised if Hallam's restriction to this country were removed. Working nearly a century before the time when the astronomical discoveries of Newton had originated the idea of attraction at a distance, he established a complete formulation of the interaction of magnets by what we now call the exploration of their fields of force. His analysis of the facts of magnetic influence, and incidentally of the points in which it differs from electric influence, is virtually the one which Faraday re-introduced. A cardinal advance was achieved, at a time when the Copernican astronomy had still largely to make its way, by assigning the behaviour of the compass and the dip needle to the fact that the earth itself is a great magnet, by whose field of influence they are controlled. His book passed through many editions on the Continent within 40 years; it won the high praise of Galileo. Gilbert has been called "the father of modern electricity" by Priestley, and "the Galileo of magnetism" by Poggendorff.

When the British Association last met at Bradford in 1873, the modern theory which largely reverts to Gilbert's way of formulation, and refers electric and magnetic phenomena to the activity of the æther instead of attractions at a distance, was of recent growth: it had received its classical exposition only two years before by the publication of Clerk Maxwell's treatise. It was not until 1887 that Hertz, by the discovery of the æthereal radiation of long wave length emitted from electric oscillators, verified the hypothesis of Faraday and Maxwell, and initiated a new era in the practical development of physical science.

Equally striking has been the great mastery obtained during the last 20 years over the practical manipulation of electric power. The installation of electric wires as the nerves connecting different regions of the earth had attained the rank of accomplished fact so long ago as 1857, when the first Atlantic cable was laid. It was largely the theoretical and practical difficulties, many of them unforeseen, encountered in carrying that great undertaking to a successful issue, that necessitated the elaboration by Lord Kelvin and his coadjutors of convenient methods and instruments for the exact measurement of electric quantities, and thus prepared the foundation for the more recent practical developments in other directions. The possibilities of transmitting power to great distances at enormous tension, and therefore with very slight waste, along lines merely suspended in the air, are being practically realised; and the advantages thence derived are increased manifold by the almost automatic manner in which the electric power can be transformed into mechanical rotation at the very point where it is desired to apply it. We are here dealing primarily with the flawless continuous medium which is the transmitter of radiant energy across the celestial spaces; the part played by the coarsely constituted material conductor is only that of a more or less imperfect guide which directs the current of æthereal energy.

In theoretical knowledge, a new domain has recently been acquired through the experimental scrutiny of the electric discharge in rarefied gaseous media. The study of the very varied electric phenomena of vacuum tubes, in which the material molecules are so sparsely distributed as but rarely to interfere with each other, has conduced to enlarged knowledge and verification of the fundamental relations in which the individual molecules stand to all electric phenomena, culminating recently in the actual determination, by J. J. Thomson and others, of the masses and velocities of the particles that carry the electric discharge across the exhausted space. The recent investigations of the circumstances of the electric dissociation produced in the atmosphere and in other gases by ultra-violet light, the Röntgen radiation, and other agencies, constitute one of the most striking developments in experimental molecular physics since Graham determined the molecular relations of gaseous diffusion and transpiration more than half a century ago. The atoms or ions are now definitely introduced as the carriers of those electric charges which interact across the æther, and so produce the electric fields whose transformations were the main subject of Maxwell's original theory.

We are thus inevitably led, in electric and æthereal theory, as in the chemistry and dynamics of the gaseous state which is the department of abstract physics next in order of simplicity, to the consideration of the individual molecules of matter.

The more advanced reformers have now thrown overboard the apparatus of potential functions which Maxwell found necessary for the dynamical consolidation of his theory, retaining only the final result as a verified descriptive basis for the phenomena.

The direct recognition in some form, either explicitly or tacitly, of the part played by the æther has become indispensable to the development and exposition of general physics ever since the discoveries of Hertz left no further room for doubt that this physical scheme of Maxwell was not merely a brilliant speculation, but constituted, in spite of outstanding gaps and difficulties, a real formulation of the underlying unity in physical dynamics.

At a time when the only definitely ascertained function of the æther was the undulatory propagation of radiant energy across space, Lord Kelvin pointed out that, by reason of the very great velocity of propagation, the density of the radiant energy in the medium at any place must be extremely small in comparison with the amount of energy that is transmitted in a second of time; this easily led him to the very striking conclusion that, on the hypothesis that the æther is like material elastic media, it is not necessary to assume its density to be more than 10^{-18} of that of water, or its optical rigidity to be more than $10\ 10^{-8}$ of that of steel or glass. Thus far the æther would be merely an impalpable material atmosphere for the transference of energy by radiation, at extremely small densities but with very great speed, while ordinary matter would be the seat of practically all this energy. But this way of explaining the absence of sensible influence of the æther on the phenomena of material dynamics lost much of its basis as soon as it was recognised that the same medium must be the receptacle of very high densities of energy in the electric fields around currents and magnets. The other mode of explanation is to consider the æther to be of the very essence of all physical actions, and to correlate the absence of obvious mechanical evidence of its intervention with its regularity and universality.

On this plan of making the æther the essential factor in the transformation of energy as well as its transmission across space, the material atom must be some kind of permanent nucleus that retains around itself an æthereal field of physical influence, such as, for example, a field of strain. We can recognise the atom only through its interactions with other atoms that are so far away from it as to be practically independent systems; thus our direct knowledge of the atom will be confined to this field of force which belongs to it. So long as we cannot isolate a single molecule, but must deal observationally with an innumerable distribution of them, even this kind of knowledge will be largely confined to average values. But the last half-century has witnessed the successful application of a new instrument of research, which has removed in various directions the limitations that had previously been placed on the knowledge to which it was possible for human effort to look forward. The spectroscope has created a new astronomy by revealing the constitutions and the unseen internal motions of the stars. Its power lies in the fact that it does take hold of the internal relations of the individual molecule of matter, and provide a very definite and detailed, though far from complete, analysis of the vibratory motions that are going on in it; these vibrations being in their normal state characteristic of its dynamical constitution, and in their deviations from the normal giving indications of the velocity of its movement and the physical state of its environment.

The dynamics of the æther, in fact the recognition of the existence of an æther, has, as a matter of history, been reached through study of the dynamical phenomena of matter. When the dynamics of a material system is worked up to its purest and most general form, it becomes a formulation of the relations between the succession of the configurations and states of motion of the system, the assistance of an independent idea of force not being usually required. We can, however, only attain to such a compact statement when the system is self-contained, when its motion is not being dissipated by agencies of frictional type, and when its connections can be directly specified by purely geometrical relations between the co-ordinates, thus excluding such mechanisms as rolling contacts. The course of the system is then in all cases determined by some form or other of a single fundamental property, that any alteration in any small portion of its actual course must produce an increase in the total "Action" of the motion. Whatever views may be held as to the ultimate significance of this principle of Action, its importance, not only for mathematical analysis, but as a guide to physical exploration, remains fundamental. When the principles of the dynamics of material systems are refined down to their ultimate common basis, this principle of minimum is what remains. The ultimate test that a system is a dynamical one is not that we shall be able to trace mechanical stresses throughout it, but that its relations can be in some way or other consolidated into accordance with this principle of minimum Action.

Are we then justified in treating the material molecule, so far as revealed by the spectroscope, as a dynamical system coming under this specification? Its intrinsic energy is certainly permanent, and not subject to dissipation, otherwise the molecule would gradually fade out of existence. The extreme precision and regularity of detail in the spectrum shows that the vibrations which produce it are exactly synchronous, whatever be their amplitude, and in so far resemble the vibrations of small amplitude in material systems. As all indications point to the molecule being a system in a state of intrinsic motion, like a vortex ring, or a stellar system in astronomy, we must consider these radiating vibrations to take place around a steady state of motion which does not itself radiate, not around a state of rest. Now not the least of the advantages possessed by the Action principle, as a foundation for theoretical physics, is the fact that its statement can be adapted to systems involving in their constitution permanent steady motions of this kind, in such a way that only the variable motions superposed on them come into consideration.

It is now verified that the Action principle forms a valid foundation throughout electro-dynamics and optics; the introduction of the æther into the system has not affected its application. It is therefore a reasonable hypothesis that the principle forms an allowable foundation for the dynamical analysis of the radiant vibrations in the system formed by a single molecule and surrounding æther.

The single principle of Action has been shown to provide a definite and sufficient basis for electro-dynamics; yet when, for example, one armature of an electric motor pulls the other after it without material contact, and so transmits mechanical power, no connection between them is indicated by the principle such as could by virtue of internal stress transmit the pull. The essential feature of the transmission of a pull by stress across a medium is that each element of volume of the medium acts by itself, independently of the other elements. The stress excited in any element depends on the strain or other displacement occurring in that element alone, and the mechanical effect that is transmitted is considered as an extraneous force applied at one place in the medium, and passed on from element to element through these internal pressures and tractions until it reaches another place. We have, however, to consider two atomic electric charges as being themselves some kind of strain configurations in the æther; each of them already involves an atmosphere of strain in the surrounding æther which is part of its essence, and cannot be considered apart from it; each of them essentially pervades the entire space, though on account of its invariable character we consider if as a unit. Thus we appear to be debarred from imagining the æther to act as an elastic connection, which is merely the agent of transmission of a pull from the one nucleus to the other, because there are already stresses belonging to and constituting an intrinsic part of the terminal electrons, which are distributed all along the medium.

The remark has often been made that it is probably owing to Faraday's mathematical instinct, combined with his want of acquaintance with the existing analysis, that the modern theory of the æther obtained a start from the electric side. Through his teaching and the weight of his authority, the notion of two electric currents exerting their mutual forces by means of an intervening medium, instead of by direct attraction across space, was at an early period firmly grasped in this country. In 1845 Lord Kelvin was already mathematically formulating, with most suggestive success, continuous elastic connections, by whose strain the fields of activity of electric currents or of electric distributions could be illustrated; while the exposition of Maxwell's interconnected scheme, in the earlier form in which it relied on concrete models of the electric action, goes back to almost 1860. The dynamics of a solid body can be confined to a discussion of its three components of translation and its three components of rotation, instead of the motion of each element of its mass. With the number of independent co-ordinates thus diminished, when the initial state of the motion is specified the subsequent course of the complete system can be traced; but the course of the changes in any part of it can only be treated in relation to the motion of the system as a whole. It is just this mode of treatment of a system as a whole that is the main characteristic of modern physical analysis. The way in which Maxwell analysed the interactions of a system of linear electric currents, previously treated as if each were made up of small independent pieces or elements, and accumulated the evidence that they formed a single dynamical system, is a trenchant example. The interaction of vortices in fluid form a very similar problem, which is of special note in that the constitution of the system is there completely known in advance, so that the two modes of dynamical exposition can be compared. Helmholtz opened up new ground in the abstract dynamics of continuous media when he recognised (after Stokes) that, if the distribution of the velocity of spin at those places in the fluid where the motion is vortical be assigned, the motion in every part of the fluid therein is kinematically involved. This, combined with the theorem of Lagrange and Cauchy, that the spin is always confined to the same portions of the fluid, formed a starting point for his theory of vortices, which showed how the subsequent course of the motion can be ascertained without consideration of pressure or other stress.

The main import of this advance lay, not in the assistance which it afforded to the development of the complete solution of special problems in fluid motion, but in the fact that it constituted the discovery of the types of permanent motion of the system, which could combine and interact with each other without losing their individuality, though each of them pervaded the whole field. This rendered possible an entirely new mode of treatment.

The new train of ideas introduced into physics by Faraday was thus consolidated and emphasised by Helmholtz's investigations of 1858 in the special domain of hydrodynamics. In illustration let us consider the fluid medium to be pervaded by permanent vortices circulating round solid rings as cores: the older method of analysis would form equations of motion for each element of the fluid, involving the fluid pressure, and by their integration would determine the distribution of pressure on each solid ring, and thence the way it moves. This method is hardly feasible even in the simplest cases. The natural plan is to make use of existing simplifications by regarding each vortex as a permanent reality, and directly attacking the problem of its interactions with the other vortices. The energy of the fluid arising from the vortex motion can be expressed in terms of the positions and strengths of the vortices alone; and then the principle of Action, in the generalised form which includes steady motional configurations as well as constant material configurations, affords a method of deducing the motions of the cores and the interactions between them. If the cores are thin they in fact interact mechanically, as Lord Kelvin and Kirchhoff proved, in the same manner as linear electric currents would do; though the impulse thence derived towards a direct hydro-kinetic explanation of electro-magnetics was damped by the fact that repulsion and attraction have to be interchanged in the analogy.

It is not surprising, considering the previous British familiarity with this order of ideas, that the significance for general physics of Helmholtz's doctrine of vortices was eagerly developed in this country, in the form in which it became embodied through Lord Kelvin's famous illustration of the constitution of matter, as consisting of atoms with separate existence and mutual interactions. This vortex-atom theory has been a main source of physical suggestion because it presents, on a simple basis, a dynamical picture of an ideal material system, atomically constituted, which could go on automatically without extraneous support. The value of such a picture may be held to lie, not in any supposition that this is the mechanism of the actual world laid bare, but in the vivid illustration it affords of the fundamental postulate of physical science, that mechanical phenomena are not parts of a scheme too involved for us to explore, but rather present themselves in definite and consistent correlations, which we are able to disentangle and apprehend with continually increasing precision.

The most definite type of model yet imagined of the physical interaction of atoms through the æther is, perhaps, that which takes the æther to be a rotationally elastic medium after the manner of MacCullagh and Rankine, and makes the ultimate atom include the nucleus of a permanent rotational strain configuration, which, as a whole, may be called an electron. All that is needed is a postulate of free mobility of this nucleus through the æther. This is not an unreasonable postulate, because a rotational æther has the properties of a perfect fluid medium except where differentially rotational motions are concerned, and so would not react on the motion of any structure moving through it except after the manner of an apparent change of inertia. It thus seems possible to hold that such a model forms an allowable representation of the dynamical activity of the æther, as distinguished from the complete constitution of the material nuclei between which that medium establishes connection.

No time is now left for review of the methods of molecular dynamics. Here our knowledge is entirely confined to steady states of the molecular system; it is purely statical. In ordinary statics and the dynamics of undisturbed steady motions, the form of the energy function is the sufficient basis of the whole subject. This method of energy is a particular case of the method of action: but in its extension to thermal statics it is made to include chemical as well as configurational changes, and a new point appears to arise. Whether we do or do not take it to be possible to trace the application of the principle of action throughout the process of chemical combination of two molecules, we certainly here postulate that the static case of that principle, which applies to steady systems, can be extended across chemical combinations. The question is suggested whether extension would also be valid to transformations which involve vital processes. This seems to be still considered an open question by the best authorities. If it be decided in the negative a distinction is involved between vital and merely chemical processes.

It is now taken as established that vital activity cannot create energy, at any rate in the long run which is all that can from the nature of the case to be tested. It seems not unreasonable to follow the analogy of chemical actions, and assert that it cannot in the long run increase the mechanical availability of energy—that is, considering the organism as an apparatus for transforming energy without being itself in the long run changed.

In any case it would appear that there is small chance of reducing these questions to direct dynamics.

Our survey tends to the result, that as regards the simple and uniform phenomena which involve activity of finite regions of the universal æther, theoretical physics can lay claim to constructive functions, and can build up a definite scheme; but in the domain of matter the most that it can do is to accept the existence of such permanent molecular systems as present themselves to our notice, and fit together an outline plan of the more general and universal features in their activity. Our well-founded belief in the rationality of natural processes asserts the possibility of this, while admitting that the intimate details of atomic constitution are beyond our scrutiny and provide plenty of room for processes that transcend finite dynamical correlation.

THE DISPOSAL OF HOUSE REFUSE IN BRADFORD.

By J. McTaggart, A.M.I.M.E., Cleansing Superintendent, Bradford.

(Section G. September 6th. Abstract.)

The disposal of house refuse is a problem which has occupied the attention of many cities and towns during the last few years, and to none has the solution been more difficult than to the city of Bradford.

Upwards of 20 years ago this difficulty was recognised in Bradford. Sanitary requirements were becoming more severe, suitable tipping places scarce, and the farmers more chary of using refuse which was gradually depreciating in manurial value.

The Sanitary Committee of the Bradford Corporation at that time gave a very considerable amount of time and attention to this question, with the result that early in 1880 the first destructor of six cells was erected at Hammerton Street by Messrs. Manlove, Alliott & Co. Subsequently the number of cells was doubled at this place, and these were followed by the erection of a four-cell destructor at Southfield Lane in 1883, the number of cells afterwards being increased to six. The Sunbridge Road destructor of nine cells, and the Cliffe Road destructor of eight cells followed in 1891, the total number of cells then being 35, capable of destroying at that time 250 tons of house refuse per day, or nearly the whole of the refuse collected at that time.

The whole of these destructors have been kept at work ever since. In 1897 the 12 cells at Hammerton Street were rebuilt under the "Horsfall" patents, and early in the present year the contract for the rebuilding of the Southfield Lane destructor was placed in the hands of the same company.

In November, 1899, the boundaries of the city were considerably extended by the inclusion of the North Bierley, Idle, Eccleshill, Tong and Thornton townships, and perhaps it would be as well, before proceeding further, to give a few particulars of the enlarged city.

The population of the city is estimated at 292,300; the acreage is 22,843; the average number of people per acre 12·8, and the rateable value is £1,396,067 7s. 6d.

The total quantity of refuse collected amounts to 125,000 loads per annum, from 32,164 ashpits, to which 180,000 visits are paid during that time, giving an average of 3·87 loads per ashpit, and 5·6 visits per year.

At the present time about 90,000 loads are destroyed annually at four destructors, the remainder being either tipped in the out-districts or sold to farmers.

The latter method of disposal is becoming extremely difficult in Bradford, owing to our disadvantage in being somewhat removed from the agricultural districts.

In order to deal effectually with the whole of the refuse collected, the Bradford Cleansing Committee decided some time ago to invite tenders for the erection of five additional refuse destructors in various parts of the city, capable of destroying altogether 180 tons per day. These tenders will be dealt with during the next week, and it is the intention of the Cleansing Committee to push on this work as rapidly as possible, so that we may be able to destroy the whole of the refuse collected in the city during the next year, a condition of affairs which I venture to say exists in very few cities or towns at the present time.

In the specification for these new destructors, the Cleansing Committee have aimed at the provision of a refuse destructor which will be an acquisition to the districts in which they are placed, and a few particulars from the specification may not be out of place here. They are as follows:—

The Cleansing Committee will give preference to any complete and well-considered scheme which embraces the following objects:—

1. The least possible handling of the refuse after being tipped at the destructor, the total abolition of the customary "pit" and of the employment of chargers, being aimed at.

2. The design of furnace which is calculated to give the highest destroying efficiency, taking into consideration the cost of working and repairs.

3. The scheme which is calculated to give the highest evaporative efficiency, bearing in mind the fact that the destruction of refuse, without nuisance, is the first consideration.

4. The scheme which has for its object the lessening of the labour and preventing nuisance, consequent upon frequent "clinkering," and for the automatic removal or conveying of clinker, and the cooling of the same, will receive the most favourable consideration of the Committee.

If the successful design complies with all these conditions, there is no doubt but that the Cleansing Committee have completely disarmed the sentimental objectors who generally appear in a neighbourhood in which it is proposed to erect a destructor.

At the present time the total number of cells in Bradford is as follows:—

Working	29
Re-building	6
	35
To be erected...	18
Total	53

These, when complete, will have a total destroying capacity of 145,000 loads per annum.

Our principal depôt is situated at Hammerton Street. Here are the general offices of the department, a 12-cell Horsfall destructor, stabling for 30 horses, mechanics', blacksmiths', and cartwrights' shops, slab making plant, electric lighting installation and disinfecting station.

The destructor proper consists of two blocks of six cells, of the back-to-back type, with two 11 feet by 8 feet multitubular boilers, the chimney being placed between the two blocks of cells. Each block of cells has a flue leading to one of the boilers, and an alternative flue leading direct to the chimney. Owing to the failure of the original cells after 17 years' service, special precautions were taken when they were reconstructed, to ensure them being of the strongest possible construction.

The end and division walls are much heavier, and the staying of the structure is carried out on a much improved plan altogether. It is stayed by heavy rolled steel joists 8 inches by 4 inches, two being placed vertically between each cell. There are also two 12 inches by 3 inches steel channels running the whole length of the furnaces, the whole being tied together with 1¼-inch tie-bolts, swelled to 1⅝ inches to receive the nut, cast-steel washer blocks, and heavy spring washers to allow a limited freedom for the expansion of the furnaces. Various other improvements were made in connection with these furnaces, not the least important being the arrangement of small air flues under the tipping floor; these flues are connected with the steam jets, which induce a current of cold air to pass along continuously, thereby preventing the heating and stewing of the refuse, so common in some of the older types of destructors.

The cast-iron air boxes built in the sides of the furnaces is another improvement which commends itself, owing to the decreased cost of repairs. In fact, the Bradford Corporation have every reason to be satisfied with the "Horsfall" furnace; the cost of repairs for the 12 cells at Hammerton Street, for the three years they have been at work, has not been £30.

Another important adjunct to this destructor is the overhead railway for the removal of clinker from the furnaces. This railway, the first, I believe, erected in connection with a destructor, is of immense benefit to the stoker, and a municipality will soon recoup itself for the cost, by the increase of work done.

During the period commencing June 24th, and ending July 7th last, a working test of this destructor was made, and I have much pleasure in submitting the results to you.

Tests of the "Horsfall" Destructor, Hammerton Street, Bradford, June 24th to July 7th, 1900.

Number of cells			12
Type			...Back-to-back.
Duration of test			278 hours.
Nature of fuel			Midden, market and dry refuse.
Number of men employed ...			12 furnace men, six chargers.
Wages			Furnace men, 28s.; chargers, 25s.
		lbs.	tons.
Total quantity of refuse burned		2,896,320	1,293
Total quantity of refuse burned per cell per 24 hours		20,837	9·3
Total cubic feet of refuse burned per cell per 24 hours		543	
Total quantity of refuse burned per cell per hour		868	
Total quantity of refuse burned per square foot of fire grate per hour		34	
Cost of labour per ton destroyed		9d.	
		lbs.	
Total weight of water evaporated		2,153,000	
Total weight of water evaporated per hour		7,744	
Total weight of water evaporated per cell per hour		645	
Water evaporated per lb. of refuse burned		·743	
" " " " " from and at 212 F.		·882	
Weight of clinker produced...		817,516	364·96
Weight of fine ash produced		26,936	12·02
Weight of flue dust produced		5,992	2·67
Total weight of residuals		850,444	379·65
Percentage of residuals		29·36 %	
Steam pressure maintained (by recorder)...		60 lbs.	
Temperature of feed water		60° F.	
Temperature of gases in main flue		1,800° F.	
Temperature of gases at chimney bottom ...		1,000° F.	
Average air pressure (water gauge) ...		¾ inch	
Total I.H.P. per hour at 20 lbs.		387·2	
Total I.H.P. per cell continuously		32·2	
I.H.P. hours per ton burned		83·2	

During the test the power generated was utilised in the following manner:—

	£	s.	d.
306 tons, 13 cwts., 2 qrs. of mortar made and sold, value	82	8	6
442 tons of crushed clinker sold	14	14	8
245 sq. yds. of concrete flags manufactured, value ...	38	15	10
3 tons, 3 cwts., 3 qrs. old tins sold, value	0	15	11
About 4 tons of fish guano manufactured	12	0	0
	£148	14	11

The whole of the water evaporated was measured through a "Kennedy" water meter, fixed direct to the boiler.

As you will see, this test is a record of a complete fortnight's work, which in my opinion is the shortest period of time that a test of this nature should cover. Fictitious results may be obtained by some of the one, two, and up to twelve hour's tests usually shown by makers, as the stokers and other men employed may make a special effort for a few hours, which they would be unable to sustain during a two week's test. Then, again, if a 12 hours' test is made, say, in the middle of the week, it would be erroneous to assume that 12 times the quantity destroyed during that time would represent a complete week's work. There is always a period at the beginning and the end of a week when the rate of combustion is very low. Then, again, the nature of the refuse varies day by day. In fact, at one period of this test, we were destroying refuse at the rate of 12 tons per cell per day.

The low rate of evaporation per pound of refuse destroyed is due to the type of boiler we have, the gases simply passing through the tubes and escaping to the chimney, as a glance at the chimney temperature will show. I might mention that every care has been taken to have this test thoroughly reliable. All the refuse has been weighed on arrival at the destructor, and the residuum carefully weighed day by day. All flues were swept out before starting, and at the completion were swept out again and the contents weighed. I might also draw your attention to the bulkiness of the refuse dealt with due to the time of the year the test was made.

The disposal of the residuum or clinker from refuse destructors has been a source of much trouble in nearly every town where destructors have been installed. Up until 1894, it cost the Corporation of Bradford over £1,000 per annum to cart the clinker to tips. Since that time, however, we have been very successful in our efforts to utilise in various ways the large amount of clinker we produce. Additional mortar mills have been erected, clinker crushing and screening machinery has also been introduced, with the result that at two of our destructors, Hammerton Street and Cliffe Road, we sell the whole of the clinker produced. At Sunbridge Road, we dispose of one-half at the present time, and at Southfield Lane machinery is being installed to utilise the whole

country, in the form in which it became embodied through Lord

hands of the same company.

production. At the present time we have eight mortar mills at work, and we are turning out mortar at the rate of 12,000 tons per annum. During the 12 months ended March 31st, 1900, we sold 15,000 loads of screened clinker at our various destructors, which, at 8d. per load, produced a revenue of £500. Had we been compelled to remove this, as in former times, the cost, at 1s. 5d. per load, the price paid to the contractor, would have amounted to £1,060, plus the cost of tipping.

We produce the screened clinker in four sizes, and the uses to which it is put are many and varied. It has been extensively used for concrete work in connection with the recent tramways extensions in Bradford; at the electric power station extensions in foundations and engine beds, and in the sewage and street cleansing departments, while the finest, or No. 4 size, is eagerly purchased by plasterers, and takes the place of river sand.

Another method of profitably utilising this residuum is in the manufacture of artificial stone. We have lately installed at our Hammerton Street works a complete hydraulic plant for this work, not perhaps so much with the object of utilising the clinker, for which we have a ready sale, but to utilise the steam produced.

The installation comprises a powerful hydraulic press, working at a pressure of 2 tons per square inch. In conjunction with this press are two sets of moulds, which enable us to keep the press working continuously, one mould being under pressure while the other is being filled.

The machine is capable of producing 200 slabs per day of 9½ hours.

The slabs are made in a variety of ways, some with a facing of granite chippings and Portland cement, ¾-inch thick, in the proportion of three to one, the remainder of the slab, which is 2½ inches thick altogether, being composed of clinker and cement in the same proportion. The slabs are also made from clinker and cement alone; these slabs can be produced much cheaper, and are very suitable for side streets, back yards, and cellaring. Some of the neatest and best slabs we have yet manufactured are composed of bluestone chippings and cement in the proportion of three to one. As these can be sold at the same price as granite-faced slabs, they are likely to become very popular. The price fixed for these slabs is 3s. 2d. per square yard, but I am anticipating being able to recommend to my Committee to still further reduce this price at an early date.

Still another, and perhaps the most profitable way of utilising clinker, especially when large quantities have to be dealt with, is in the manufacture of concrete bricks. During the last two years I have conducted a series of experiments in this direction on behalf of my committee, and the results have been so satisfactory that it is intended to lay down one or more plants at some of our new destructors. These bricks are eminently suitable for any class of inside walling. They can be produced in any shape or colour, and the machinery required is not expensive, and no drying kilns are necessary.

These bricks, when made from a 10 per cent. mixture of hydraulic lime and clinker, and properly seasoned, are nearly 50 per cent. stronger than the ordinary building brick used in Bradford, and they can be manufactured at a cost of 14s. per 1,000. For utilising large quantities of clinker in districts where its sale in other forms is limited, there can be no better method, the product always being in demand, and a small machine turning out 8,000 bricks per day, will require over 20 tons of clinker for that purpose.

Should the drying space be limited, these bricks can be thoroughly dried, hardened, and made ready for use in eight hours, by the use of high pressure steam, and in connection with refuse destructors where steam is usually plentiful, this process does not add materially to the cost.

Samples of these bricks were tested by our technical college staff, and the results show that they should be kept at least three months before using, if they are naturally dried, the increase of strength during the last four weeks being remarkable.

Before leaving this subject, I should like to draw your attention to yet another method of profitably utilising clinker in a more artistic way. I refer to the manufacture of ornamental tiles. Special and inexpensive machinery has been designed for this work, by the use of which one man is capable of producing 750 encaustic tiles, similar to that shown, or from 3,000 to 4,000 plain tiles per day, each tile being subjected to a pressure of 60 tons.

There is always a good demand for ornamental tiles, and these can be manufactured at a cost which, at the prices usually quoted for similar goods, leaves a very handsome profit indeed.

Another portion of the residuum from town's refuse which formerly was the source of considerable trouble, is the old iron, tins, &c., collected from the ashpits. Happily, we have overcome our difficulty in this direction. Our Corporation chemical works take a small proportion of the tins, &c., their ultimate use being in connection with the treatment of the city sewage. The remainder is put on rail, and consigned to a neighbouring chemical works. We receive 5s. per ton at our works for this refuse. The scrap iron we readily dispose of to local dealers and ironfounders at from 25s. to 40s. per ton. The total revenue from this source amounts to £150 per annum.

The utilisation of the steam produced at our various refuse destructors in a profitable manner is a subject to which the Cleansing Committee have given every consideration. In addition to the slab making plant recently erected, we have an artificial manure plant at work at Hammerton Street, where the whole of the fish refuse of the city is treated and converted into a valuable manure. This plant consists of a large steam jacketted pan, having a central shaft passing through stuffing boxes at either end, and to which are attached a number of arms or agitators, which are kept revolving when the pan is at work, by means of powerful gearing driven by a horizontal engine, which is supplied with steam from the jacket of the pan, a double duty being thus obtained from the steam. We deal with 600 or 700 tons of this refuse per annum, which is reduced to 25 per cent. of its original bulk. The product we sell at £3 per ton at our works, and needless to say, this branch of refuse disposal is a very profitable one for the department, the process and machinery requiring very little attention.

At these works we have also a disinfecting station containing a Washington Lyons disinfector, in which the whole of the infected clothing, bedding, &c., collected in the city is treated. The machine requires a very considerable amount of steam for its efficient working, and the Health Committee, to whom it belongs, allow the Cleansing Committee the sum of £50 per annum for the supply thereof.

We have also a 100-H.P. engine at work here driving the mortar mills, clinker-crushing machinery, blowers, &c.; a 40-B.H.P. high speed engine and dynamo, lighting up the whole of the works and adjoining streets; a 20-H.P. engine also runs the machinery in the mechanics' shops, and the chopping and grinding machinery, crane, &c., connected with the stables.

These, together with the 40-H.P. engine required for the steam jets in connection with the destructor, utilise the whole of the steam produced at the present time. Should we at any time require an additional supply, up to double the present amount, it could be easily obtained by the use of economisers, or the substitution of a different type of boiler for the present wasteful ones, as a glance at the temperature of our chimney gases will prove.

At our other depôts the methods adopted to utilise the steam produced are somewhat similar, our first object in all cases being to utilise it as far as possible in still further disposing of the residuum from the furnaces.

In the earlier part of the paper I quoted the specification which we had issued in connection with the erection of our new destructors. It may be thought that we are asking for the impossible, in specifying so many departures from the ordinary types of destructors in use, yet we seek nothing that is not embodied in the design of the new destructor which we are erecting at Southfield Lane.

The draft designs of this destructor have been prepared by the Corporation, who accept full responsibility for the efficient working of the plant. The drawings have been prepared by the Horsfall Furnace Syndicate, to whom the contract for the erection of the six cells has been entrusted.

Here, the usual "pit" or "tip" is abolished, the refuse, on its arrival at the destructor, being tipped direct into the furnaces. These are designed to hold a 12 to 14 hours' supply of refuse, in a large inverted hopper-shaped drying chamber, from which it can easily be pulled on to the fire bars as required. The top, or mouth of this drying chamber is closed by a heavy cast-iron door, which travels on planed horizontal surfaces, forming a perfectly air tight joint.

These doors are actuated by means of a screw and bevel gearing, and the carter on arrival with his load will simply move a lever opening the door, tip his load, and reverse the lever, suitable trip gear being fixed to throw out the friction clutch at either end of the screw.

The clinker will be removed from the furnaces by means of an overhead railway, and after being cooled will be taken to the clinker crushing machine, or elevated from the clinker floor level to the mortar mills, which are placed at the street level. The clinker crusher will have a capacity of 20 tons per hour, there being an accumulation of something like 70,000 tons of clinker from the old destructor, which we intend to utilise in this way. A 400-H.P. Lancashire boiler is being put in, designed to work at a pressure of 120 lbs. per square inch, a part of the power from which will be utilised in a 100-H.P. horizontal engine for driving mortar mills, clinker machinery, &c.

A 40-H.P. engine will also be fixed for driving the clinker elevators, friction gearing and portable railway.

A large high-speed engine and dynamo will also be erected for the lighting of the works, &c., but the details of this installation are not yet complete.

I anticipate that when this destructor is complete, it will be one of the most economical plants yet erected, capable of destroying ashpit refuse at a cost of 5½d. per ton for labour only, at the present rate of wages in Bradford. This will be accomplished owing to the abolition of the usual tipmen and chargers, and to the increased efficiency of the furnaces, as they will not require to be recharged each time they are clinkered. Should our anticipations be realised in regard to the revenue from residuals, &c., from this destructor, there is no doubt but that the City of Bradford will have made another step in the realisation of the ambition of her Cleansing Committee, viz., the destruction of the whole of the house refuse of the City without nuisance and without cost.

Discussion.

Sir A. R. Binnie said they were exceedingly indebted to Mr. McTaggart for bringing before them one of the most important matters which could engage the attention of a sanitary engineer in a large manufacturing town. The getting rid of the refuse of a large town was always in itself a serious work; but when they saw that, under Mr. McTaggart's direction, getting rid of the nuisance was about to be accomplished at no cost to the ratepayers, a most important future was opening out to that essential part of their work.

Major-General Webber, in seconding the vote of thanks, said that about nine years ago he was asked to report to the Kensington Vestry—which represented a population nearly equal to that of Bradford—on the destructors at Bradford, and at that time the two which had then been in existence did not show the results which are

work, has not been £30,

Southfield Lane machinery is being installed to utilise the whole

to-day described, and which are the outcome of further experience and had produced such happy results. The object of the Kensington Vestry in asking him to report was because at that time it was a question being mooted among electrical engineers whether the waste product from destructors of refuse could not be utilised for the generation of electricity for the purposes of distribution. At that time Kensington was building a wharf with a view to reducing the handling of the refuse brought in in carts in various parts of the district to be sent by canal into the country. This was costing 2s. a load, and they hoped to reduce it to 1s. 10d. or 1s. 9d. by that outlay. It was suggested to them that they should work an electric lighting generating plant on the same site for the utilisation of that fuel. Had he known that this paper was going to be read he would have provided himself with the remarks he made then. The calorific value of the refuse collected in London was very different from that at Bradford. He then considered that in the result produced there was no financial saving.

Mr. George Watson said that Mr. McTaggart had made an enormous advance over the authorities in any other town in the matter of dealing with his residuals. Those destructors were not in any sense automatic machines. The results depended very largely upon the manner in which they were worked. They required a man of skill, and but for Mr. McTaggart the Bradford Corporation would not have been able to do what they had done. One word in regard to electrical engineers and the use of power from destructors. It was a curious thing, but among all branches, electrical engineers were the only ones who had made serious attempts to use the waste gases. That was in a sense unfortunate, because they could only require power for such a short time every day—an average of about three hours a day, he thought—yet electrical engineers were the only branch of the profession who had utilised that power, which was available over the whole 24 hours. Now that tramways were coming into use there was hope that they would be able better to utilise that work. He believed that if Major-General Webber would refer to Mr. McTaggart's paper and the immense amount of power generated, and so on, he might be able to modify the opinion which he formed so many years ago about the utilisation of the waste gases from dust destructors.

Mr. McTaggart, in replying, said with regard to the results of generation of electricity from refuse, it was a subject which had received the consideration of the Cleansing Committee of Bradford, but so far they had not yet seen their way to go any further into the matter than simply to light their own works and the limited area adjoining them. The calorific value of the refuse they found to vary so much from day to day that they hesitated to place themselves in any position where they might be expected to deliver a certain amount of power which they would find they would be unable to do without using coal. In his opinion—and he had always recommended the Committee to adopt it—they should not try to have a duplicate plant at all. If they wished to have an electric lighting works, let them have one, and thoroughly up-to-date; if they wanted a destructor, let them have it as a destructor, and make that thoroughly up-to-date, and let them utilise every atom of power in some other useful work, such as was illustrated by the bricks and tiles, &c., on the table, and he believed it would some day prove to be as thoroughly remunerative as the generation of electricity.

A COMBINATION INTEGRATING WATTMETER AND MAXIMUM DEMAND INDICATOR.

By John H. Barker.

(*Section G. September 10th.*)

Before proceeding to describe the meter in question it is necessary to say a few words on maximum demand.

It concerns engineers more especially; every work they design or construct must be sufficiently strong to meet the greatest call which may ever be made upon it; their bridges strong enough to bear the heaviest train under the worst conditions of storm; their harbours deep enough to float the largest ship on the lowest tide. And of engineers, electricians suffer most; their plant must be sufficient to meet the maximum demand for light on any one night in the year. All their consumers need light at the same time, and Parliament says rightly they shall help themselves whenever they like. The result is shown in any supply station's daily record; [a curve was given of Cambridge, taken on the heaviest day in the year, and on the same scale was shown the demand on the works if a regular amount could be generated every day.] The actual requirement is 372 kw., the ideal 39 kw., about one-ninth. Such an ideal is impossible until economic storage is more practicable than at present. However, the object of everyone in charge of a station should be to approach a little nearer the ideal state, for there is plenty of scope.

At present electric lighting is undoubtedly more costly than gas. Consumers, as a rule, only light the more prominent parts of their houses and business premises electrically, which parts need light chiefly at the time of maximum demand, and for only one or two hours a day, using gas in basements, kitchens, and passages where light is needed for long hours, the very lights needed most by electricians to level up the hours of supply. It was evident that such lights could only be obtained if a reduced price were charged. But what is to be a fair charge? The late Dr. Hopkinson advocated a scheme that came very near to perfection in its idea; it was based on the fact that the cost of supplying each individual as regards capital outlay is proportional to his maximum demand for electricity, even though that maximum demand were only for a few minutes on one day in the year; this, therefore, should be taken as a basis for charging for the supply of current. It was further premised that unless a consumer used an amount of electricity equal to what he would have consumed were his maximum number of lamps burning for one hour per day, the supply authority could not be recouped at the statutory rate for their capital outlay and standing charges. Finally, when the consumer had received an amount of electricity equal to the above amount he might be considered to have paid his share of interest on capital, and should be allowed to have his further supply at little more than the bare cost of production. To put this scheme into practice, it is necessary to measure two quantities, the total amount of electricity used, and the maximum number of lamps or their equivalent ever lighted at one time. This system has been at work for some years with marked success, but it has been necessary to use two separate meters, one to integrate the total number of units consumed, and the second to record the maximum demand; both meters absorb energy from the supply to the detriment of the light. In conjunction with Prof. Ewing, the author has invented a meter which will combine the functions of the previous two. The external appearance is shown, and next is the explanation given to the consumer. The construction of the combined meter is shown, actual meters are on the table, and photographs are given on the screen. The maximum demand device can be attached to meters of the magnetic brake type, a prominent example of which is the meter sold by the Thomson-Houston Company, Limited. The meter is essentially a motor and a magnetic brake; the latter consists of a copper disc revolving in a horizontal plane between the poles of the permanent magnets, the magnets set up eddy currents in the disc and produce a drag which is proportional to the speed of the rotation. In carrying out the invention this drag is made use of. The two magnets are supported on a beam and suspended in such a manner that they tend to follow the rotation of the disc. [A section of the suspension was shown.] A steel wire enclosed within a tube is fixed at its upper end to a screw; at its lower extremity it is secured to the beam itself. The torsion of the steel wire acts as a spring and controls the distance through which the suspended system moves.

The spring or other controlling force is made comparatively strong in order that the motion of the magnet poles may be so small as not to affect the rate of the meter, and also in order that the period of oscillation of the suspended system may be short. When a sudden increase takes place in the demand for current, and consequently in the rate of supply, the magnetic brake would tend to swing beyond the position proper to the new rate of supply if its period of oscillation were not short in relation to the time taken by the revolving parts of the meter to acquire their new velocity. This tendency is obviated by making the period of oscillation of the brake sufficiently short in relation to the time during which the disc is undergoing acceleration when the current is suddenly applied or suddenly increased. Further advantages of the strong controlling force, and consequently small movement of the brake, are that the brake may be pivotted eccentrically to the disc without causing its motion to affect the rate of the meter, and also that there is no necessity for the use of a dash-pot or similar arrangement to check the oscillations, although such means may be used if desired. Again, the small motion of the brake assists in preventing disturbance of the indications through the direct effect of the motor coils in cases where continuous currents are used, and the field of the motor is produced by current in coils.

The motion of the brake is multiplied and actuates the indicator as shown. A light ratchet and pawl is fixed at one end of the beam, and retains the system at its point of maximum deflection; a lever with a sealing device passes through the outside of the case, and enables the meter inspector to reset the indicator at the end of each quarter or half year as the case may be.

In meters for measuring supply by continuous currents, care must be taken to arrange the magnetic brake so that the electric currents in the meter do not directly tend to displace it. For this purpose it is preferable to invert one of the two magnets forming the brake, so that the pair shall constitute an astatic, or nearly astatic, system. When this is done it may in some cases occur that the stray field from the magnets constituting the brake affects the field of the motor, and consequently disturbs the rate of the meter. This may be compensated for by several devices, such as introducing a separate compensating magnet to balance on the motor armature, the field produced by the magnets of the brake, or using a shunt field coil in the motor for the same purpose.

The scales for all sizes of meters are made the same, and the readings follow a straight line law; the adjustment for rates is shown; the divisions of the scale are given in percentages of full load of the meter, and a table is fixed to the front of each case, giving at a glance the maximum demand corresponding to any reading, as well as the number of units which must be consumed before the lower rate is charged.

Next there is shown a meter adapted for use on a switchboard; it integrates the amount of current which has passed through any feeder or from any dynamo, and informs the attendant the quantity passing through at any moment, obviating the use of an ammeter, (more properly speaking a wattmeter). It differs from the ordinary meter, inasmuch as it has no ratchet and pawl, and is free to return to its zero position on the stoppage of current through the instrument.

There are many advantages claimed for this form of demand indicator:—

(*a*) It combines in one instrument the dual function of integrating and of recording the maximum demand.
(*b*) As an indicator it absorbs no energy from the supply.
(*c*) It contains no liquid or injurious acid.
(*d*) It is not affected by any ordinary short circuit.
(*e*) It records alternating or direct current; in the case of alternating current it records true watts and not apparent watts, an important item in respect of supply to motors and arc lamps.

(*f*) It is extremely accurate [a curve at varying loads was shown].

Mr. Reginald P. Wilson, of 66, Victoria Street, some few years ago devised a maximum demand indicator embodying the same principle. A model of his meter is shown and a diagram giving the working of the same. The difficulty in this form was that the swing of the suspended system was sufficient to carry the pointer beyond its correct reading if a larger amount of current than a very small fraction of its full load were switched on at any one time, and the meter was never in commercial use. The inventors of the Barker and Ewing meter were unaware of Wilson's patent until their own was in its final form. They have, however, acquired this patent.

Discussion.

Major-General Webber asked whether the meter was in use for ordinary commercial supply in any quantities.

Mr. Barker stated that it was in use in Cambridge, and there were 150 more in practical use throughout the country. The patents were only dated a year back, and then acquiring the master patent delayed the placing of the meter upon the market for something like six months.

Mr. Alexander Siemens (who presided) said that the author had told them that the view with which the meter was brought forward was to make people use the electric light everywhere instead of as a luxury. He thought he might just as well repeat an experience of his own. Years ago he kept his gas accounts very carefully until he fitted his house for electric lighting. He introduced it into every room in the house and had no gaslight whatever. He insisted upon everybody turning out any lights he was not using, so that no room was left lighted when nobody was in it. After an experience of three years with gas and 10 years with electric light his electric light bill was actually less than the gas bill used to be. The great thing was that people must turn out the light when they did not want it. He was sure that if such facts were published and rubbed into the public, that great difficulty of the electric light companies, illustrated by Mr. Barker's curve, would be more and more reduced.

Mr. Shoolbred said that in the city of Bradford there were many consumers who had the same experience as Mr. Siemens, the electric light being found to be more economical than the gas, although the nominal rate came out more expensive.

CORRESPONDENCE.

On the Nature of the Electric and Magnetic Quantities.

Some time ago I received a copy of a criticism, by "W. A. P.," which appeared in your columns of May 25th, 1900. I must apologise for not replying to the author's very courteous communication before, but I have been extremely busy with other matters.

The criticism is a very fair one, and whilst I think that my position can be certainly maintained, there is no harm in confessing that "W. A. P." has pointed out some flaws which must be made good, or at least where the argument must be put in better and more precise shape. In only one place is his criticism unjust, and I will refer to that first. It is in his closing paragraph where he says:

"While the mode of argument appears unsound, it seems that if it could be defended it would defeat its own object. It is intended to show that μ^{-1} and H have the same dimensions. But if they have the same dimensions, B has the quality of a pure number, while on the hypothesis that k has the dimensions of density, B would have the dimensions $X Z Y^{-2}$. So that if the argument is sound, even the last possible theory of the ether left by the eliminating process fails."

This is a mistake. B is not a pure number, but has the quality of an angle. The proof of this is given on page 85, and I have never stated that B has the quality of a pure number. The slip probably occurred from "W. A. P." not noticing that, in equation 2, I do not deal with the direction of the lengths, and that when this is done, as for instance on page 88, the equation has to be written

$$\text{curl}_Q P = M L^2/T,$$

where I have shown that "curl" has the quality of an angle.

If this be taken into account, it will be found that I am correct, and that "W. A. P.'s" objection does not hold.

In the first part of his criticism my argument is very fairly and correctly stated. I first corroborate Williams's results. I then show that if k is a density, there should be a linear relation between μ and H, and that k should vary with the square of F; whilst if μ is a density the reverse should be the case.

I next show that there does exist a linear relation between μ and H, and give other corroborative evidence, such, for instance, as the relation between μ and the elasticity and between k and the density.

At that time I had not found the relation between k and the square of F which I indicated as existing (paper p. 109) but not yet discovered. I have, however, since found it. It is simply Kerr's phenomena, the full statement of which I have found to be as follows:—

"*In a dielectric under electric stress, there is a change of density proportional to the square of the slope of electric potential, and to the inverse first power of the coefficient of compressibility.*"

This same phenomenon is the cause of gravitational attraction, as I have pointed out in a recent paper in the *Electrical World and Engineer*. The self-inductance of a moving electret gives us its inertia, and the change of density due to its charge gives us its gravitational attraction.

It is objected that I use dimensions in an entirely different way to any previously followed. This is true, for what I have done is to develop the old "dimensions" into a new and much more powerful branch of mathematics, which I have called "Qualitative Mathematics." The relation of this branch of mathematics to dimensions is of the same nature as the relation between arithmetic and algebra. As an example of this new method, I give a proof of Dulong and Petit's law, deducing it from the laws of Boyle, Charles, and Avocado.

Let s be the specific heat, *i.e.*, the energy required to raise one gm. of the substance, 1 C. Then, M being the mass, θ the temperature, L length, and T time, we have

$$\text{mass} \times \theta \times s = M L^2/T^2,$$

$$\text{therefore} \quad \theta = M L^2/T^2 \times 1/M s = L^2/T^2 s.$$

But $P V = R \theta$, and atomic volume is proportional to density of gas at a given temperature and pressure, therefore

$$\text{Atom. wt.} = (\text{Density} \times \theta) / (\text{pressure} \times \text{No. of atoms per mol.}) = T^2 \theta / (L^3 \times \text{No. of atoms per mol.})$$

$$\text{Therefore} \quad \theta = (L \times \text{mol. wt.}) / T^2 = L^2 / T^2 s.$$

$$\text{Whence} \quad s = 1 / \text{mol. wt.}$$

I had meant to take up the question of the linear relationship between quantities, as indicated by their qualities, and to explain the limitations of this, but find that will take up too much space. So for the purpose of this discussion, we will take my critic's views to be quite correct; as indeed they are, for my statements in the matter require to be qualified and explained much more fully than I have done in the paper. But granting this, they do not affect the main question, *i.e.*, the nature of the electric and magnetic quantities. For, to take "W.A.P.'s." illustration. Suppose that I have four quantities, A, B, a and b. Suppose I have never seen a triangle, but have proved in some way that either A must be the arc, B the angle, a the radius, and b the area, or that A is the radius, B the area, a the arc, and b the angle. So far I cannot tell which is which, I know which go in pairs, but not which pair is which.

But suppose that I have also proved that if A is the arc, that it will vary directly with B, whilst a will vary as b squared, whilst if a is the arc the relations will be reversed. Then, if I take the triangle up, and alter the angle, and find that A does vary directly with B, whilst a varies as b squared, am I not absolutely justified in saying that A is the arc, B the angle, &c.?

Now this is what I have done in the case of the electric and magnetic quantities. I have shown that either k or μ is a density, and that if k is the density, μ must vary with H and k with F squared; and if μ is a density, these relations will be interchanged. Then I have shown that μ *does* vary with H and k with F squared. Therefore, I believe that there is no escape from the conclusion that I have definitely and finally settled the nature of the electric and magnetic quantities.

In addition to this, moreover, I have shown that many other relations are in accordance with the facts, such as the relation between elasticity and permeability, between k and density, permeability and strain, the constant a and hysteresis, &c.

Consequently, though the criticism of "W. A. P." is in

many respects justified, and my argument needs, as he has shown, to be made more complete in many points, some of them of great importance, yet I believe that the main result will stand.

Reginald A. Fessenden.

The Doom of the Contractor.

Is there any room on the earth for the electrical contractor? When manufacturers quote consulting engineers and their clients trade prices it is obvious that there is not much, but when, as recently has happened in this district, a firm of consulting engineers advise their client to engage wiremen, buy material, and instal three or four thousand lights under their direct supervision, the poor contractor concludes he is to be crowded out of existence.

Shutters Up!

Liverpool.

Guard Wires.

As lengthy, and animadversary, correspondence is seldom of value, and rarely interesting to non-combatants, I do not feel inclined to waste my time and your space in correcting Mr. Quin's letter published in the last number of the REVIEW.

Except with regard to suggestion 6, about which I own to mis-reading, I would not wish to alter any portion of the article.

Whether that article does or does not express the views, or meet with the approval of the majority, is a question which could be settled by referendum; but I am doubtful if you, Sirs, will take advantage of that expedient. More probably you will thank your stars that I merely ask those interested to read Mr. Quin's paper, my article, and the letter by Mr. Quin which followed, and to agree with whoever, or whatever, they may think fit.

The case on both sides has been stated, and who reads may judge. If Mr. Quin is right throughout, well and good; if I have not stated the case for the opposition—which is, as I claim, the majority—altogether erroneously, but have simply roused Mr. Quin's ire by daring to criticise his paper, well—and better for me.

The Writer of the Article.

September 12th, 1900.

Consulting Engineers and their Specifications.

I should like to bring under your notice the following matter, on which perhaps some of your readers may have something to say:—

I had sent me by a consulting engineer a specification for certain work. When looked into, I found that almost every article specified had to be bought from some particular manufacturer, and we have reason to believe that the consulting engineer was interested in all these makers. Further, there were certain articles specified of the consulting engineer's own patents.

If the articles mentioned were goods that could only have been obtained from the firms mentioned, I could have little to object to, but such was not the case, as every article could have been obtained of at least equal quality from many other manufacturers.

Such a method of drawing a specification appears to me to be entirely wrong. A consulting engineer is paid by his client to look after his interests, and should avoid the slightest suspicion of benefiting by recommending particular makers.

In the case I mention, the result was that the tenders came to nearly twice as much as they should have done.

Philos.

September 9th, 1900.

Goods Imported.—The imports of foreign electrical goods and apparatus into this country during August last attained a value of £148,317 as compared with £129,022 in the preceding month. For the eight months ending with August a total of £697,592 is recorded.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Sept. 12th, 1899.		Week ending Sept. 11th, 1900.	
Adelaide. Teleg. wire ..	Value £767	Amsterdam	Value £70
Amsterdam	25	Bangkok	149
Antwerp	33	Bombay	36
Auckland	75	Buenos Ayres. Teleg. wire ..	88
Bombay	81	Calcutta	905
Bordeaux	10	Cape Town	507
Buenos Ayres	50	Cologne	13
,, ,, Teleg. mat. ..	125	Copenhagen. Teleg. wire ..	184
Bushire	25	Durban	906
Calcutta	257	East London	190
Cape Town	599	,, Teleg. mat. ..	44
Channel Islands	17	Fremantle	2,842
Chinde. Teleg. mat.	565	Gothenburg. Teleg. wire ..	19
Christchurch. Teleg. wire ..	124	Halifax. Teleg. apparatus ..	102
Colombo	44	Hamburg	70
Copenhagen. Teleg. wire ..	58	,, Teleg. mat.	300
Durban	94	Hiogo. Teleg. mat.	257
Flushing	124	Hong Kong	28
Gibraltar	7	Libson. Teleg. mat.	1,051
Hamburg. Teleg. mat.	65	Melbourne	2,622
Hong Kong. Teleg. mat. ..	41	,, Tramway cable ..	1,598
Ibrail	15	Nagasaki	169
Madras. Teleph. mat.	181	New York	18
Melbourne	293	Ostend	40
Ostend	123	Perth	260
Perth	41	,, Elec. motors	535
Port Said	10	Port Chalmers	141
Rotterdam	150	Port Elizabeth	416
,, Teleg. wire	57	Rangoon	12
Shanghai. Teleg. wire	116	Rio Janeiro. Teleg. wire ..	196
Singapore	348	Rotterdam. Teleg. mat. ..	161
,, Teleg. mat.	50	St. John's (N.F.)	88
Stockholm	74	St. Petersburg. Teleg. mat. ..	343
,, Teleg. wire	321	Shanghai	184
Sydney	599	Singapore	277
Tientsin	12	Stockholm. Teleg. mat. ..	27
,, Teleg. mat.	73	Sydney	1,466
Wellington	902	Wellington	27
Yokohama	218	,, Teleg. mat. ..	60
		Yokohama	56
Total ...	£6,889	Total ..	£15,786

Foreign Goods Transhipped.

Sydney. Elec. light fittings Value £25 | Perth. Elec. goods .. Value £788

Bankruptcy Proceedings.—The first meeting of creditors and the public examination of F. L. L. Lindsay, electrical and mechanical engineer, Bangor, are arranged for September 18th and October 4th respectively, at Bangor.

Notice of intended dividend has been given in *re* E. J. Paterson and C. F. Cooper (Paterson & Cooper) electrical engineers and contractors, &c., Dalston, London, Glasgow, &c. September 22nd is the last day for receiving proofs. Mr. E. C. Moore, 3, Crosby Square, London, E.C., is the trustee.

Dissolution.—The business relations between Messrs. Pritchetts & Gold and Messrs. Venner and Co., of 6, Old Queen Street, Westminster, by which the latter firm have been sole selling agents for Pritchetts accumulators for the past 4½ years, have been dissolved by mutual consent. All firms who have previously dealt with Messrs. Venner & Co. for Pritchetts accumulators are requested in future to communicate direct with Messrs. Pritchetts & Gold at their works, Feltham, Middlesex.

Catalogues and Lists.—The General Electric Company have issued a leaflet illustrating their overhead trolley line material, a large stock of which is kept in hand. A combined arc lamp switch and cut-out of novel design, sledge induction coils and a milk heater are also illustrated.

A neat booklet illustrating and describing the Monoline composing machine comes to hand from the Canadian Composing Company, Limited, of Montreal; we are informed that this machine has just received the Grand Prix at the Paris Exhibition, where it is on view.

A list comes to hand from Messrs. Ashmore, Benson, Pease and Co., Limited, of Stockton-on-Tees, giving particulars and prices of their "Invicta" accumulators for electrical ignition.

The "Albradium" Syndicate send us a leaflet explaining the special features of their new white metal, and the uses to which it is applicable.

A leaflet has come to hand from the Phosphor Bronze Company Limited, giving particulars and prices of their silicium-bronze wires for telephone and telegraph purposes. We note that the silicium-copper brand has a conductivity of 98 per cent. of that of pure copper, with a tensile strength of 28 to 31 tons per square inch; the bronze wires have conductivities varying from 85 to 30 per cent., their tensile strengths varying correspondingly from 32 to as much as 55 tons per square inch.

Messrs. Holden & Brooke, Limited, send us a booklet of "Golden Opinions," in which their "Sirius" exhaust steam injector is most highly spoken of, together with a leaflet giving particulars and prices of these well-known injectors.

The British Thomson-Houston Company's pamphlet, No. 74, describes and illustrates their small D.C. motors, type C.A., from ¼ to 2 H.P., and for pressures up to 500 volts. The magnetic circuit of these motors consists entirely of laminated iron; the Eickemeyer armature winding is used. The efficiency ranges from 60 per cent. in the small sizes to 83 per cent. in the large ones.

The Sunbeam Lamp Company, Limited, send us an abridged edition of their catalogue, giving brief particulars and prices of their high and low voltage lamps, &c., with illustrations.

(*Continued on page* 429.)

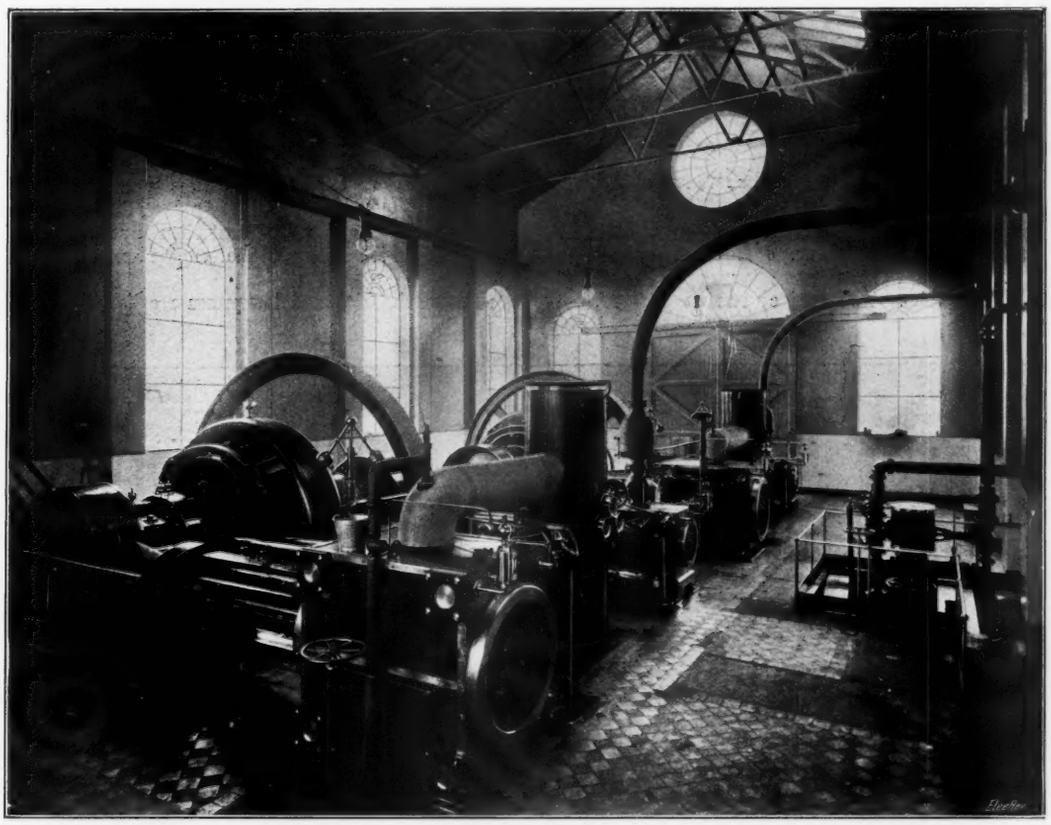
ELECTRICAL POWER TRANSMISSION IN SMELTING WORKS.

Through the courtesy of the directors of the Smelting Corporation, Limited, we were enabled last month to visit their works at Ellesmere Port, Cheshire.

The works have been erected to operate a patent for the extraction of the metals contained in refractory sulphide ores such as are largely obtained in the Broken Hill districts of Australia. The inventor of this patented process is Mr. Henry E. Fry, who developed his idea in works erected at Swansea. His aim was to obtain such a flux as would act as an antidote to the special difficulty attached to the smelting of ores containing zinc, namely, that of choking or gobbing up the furnace. This he discovered after many trials, the flux he adopted being sulphate of soda (a by-product from chemical works) and oxide of iron. With this flux the ores, after calcination, are passed through an ordinary cupola. The action is most simple, nearly all the lead and silver is at once obtained as bullion, and the whole of the zinc passes into the slag, and is dealt with subsequently in that form. The Smelting Corporation was formed in March, 1898, and has since then erected its works on a site of 60 acres on the Manchester Ship Canal at Ellesmere Port. The works were designed by Mr. W. B. Devereux, assisted by Mr. R. Addie, who has since superintended their erection, and is now acting as works manager. The total capacity of the works when complete will be 100,000 tons per annum. At present, only sufficient has been erected to deal with one-third of this. Almost the whole of the power used is electrical.

It is, perhaps, the largest private installation of electrical power transmission of its kind in the country, and is specially interesting as having been planned and laid out before the smelting works had been erected. Indeed, the erection of these and the building of the power house were carried on simultaneously: the only guidance given to Mr. Philip Dawson, of the firm of Messrs. Robert Blackwell and Co., Limited, who designed the whole scheme and acted as his own architect, being the power of the various motors required and their approximate positions.

In less than a week Mr. Dawson prepared plans, got out quantities, and placed the complete scheme before the directors of the Smelting Corporation, and it says much for his engineering ability when we state that the building and machinery, as they exist to-day, are precisely as planned, no modifications or alterations having been found necessary as the work proceeded.



Interior of Engine House.

The power station is situated in close proximity to the Shropshire Union Company's canal, from which the water supplies are taken, and also to the Smelting Corporation's private railway line running through the works. The buildings, which have been constructed of brick, consist of an engine house 75 feet × 46 feet, and a boiler room 75 feet × 46 feet, both having a clear height of 30 feet. The roof in both cases is carried by wrought-iron principals. The engine room is provided with a basement below the working floor level through which the heavy exhaust and condenser piping is led. The floor in the portions immediately above the piping is constructed of chequered wrought-iron supported by wrought-iron joists. The remainder is constructed

F

is recorded.

(Continued on page 429.)

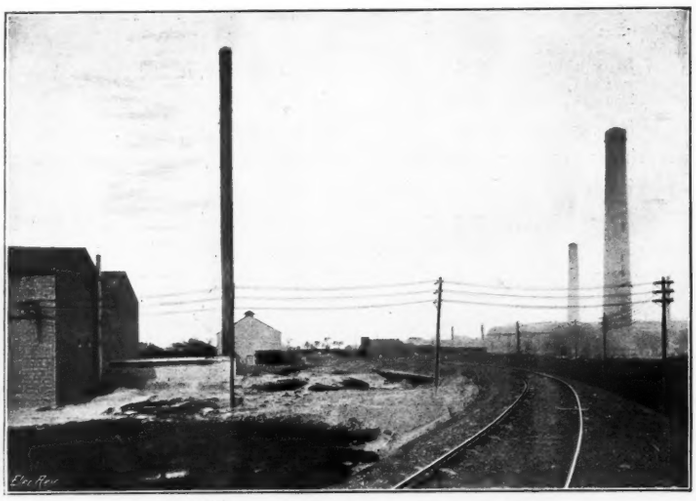
in cement arching finished on the surface with red and black tiles.

The floor of the boiler room is of cement with the necessary pipe trenches covered with chequered-iron plates.

The main flue is carried immediately behind the boilers and terminated in a wrought-iron chimney supported by steel guys.

The walls of the engine room are finished with white tiles for a height of 6 feet, the remainder being plastered and painted.

A travelling crane capable of working a load of 10 tons is fitted in the engine room and operated from the floor level by means of chain.



Power Transmission Cables Showing Mode of Support.

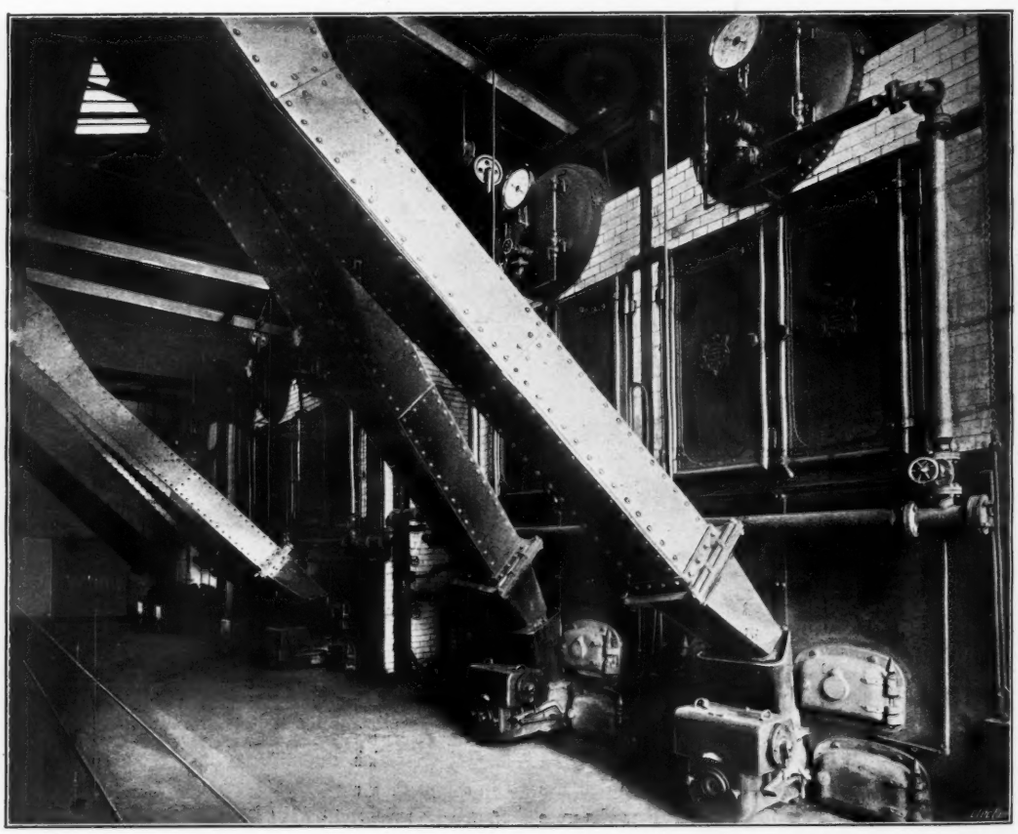
Description of Engines and Generators.

There are two horizontal cross-compound condensing engines, built by the Edward P. Allis Company, each direct coupled to a 400-kw. Crocker-Wheeler generator supplying direct current at 250 volts. The engines run at 100 revolutions per minute under a steam pressure of 120 lbs. per square inch.

The cylinders measure 19 inches and 38 inches respectively in diameter, with a stroke of 42 inches. They are made of hard, close grained cast-iron, covered with a non-conducting covering and lagged with planished sheet steel. The exhaust chambers are cast separately from the cylinders, thus reducing internal condensation to the lowest limit. The valve gear is Reynolds-Corliss automatic, with two eccentrics for each cylinder. The governor, which is of the weighted type, operates on both the high and low pressure valve gears. The wrist plates are provided with Reynolds's patent disconnecting device, whereby the valve gear can be worked by hand. The working surfaces of the valve gear are faced with hardened steel plates. These plates are square, so that all four edges can be used, and then the plate reversed, giving in all eight wearing edges. The vacuum pots are bolted to the cylinder feet. There is a special stop valve controlled by supplementary regulation which prevents the engine exceeding a fixed speed.

Between the high and low pressure cylinder is placed a reheater receiver, provided with traps to drain off the condensed water.

The engine frame is the Allis Company's heavy "1890" rolling mill pattern, cast with a plate in the base to form a receptacle for oil thrown off by the crank-pin, journal, or slides.



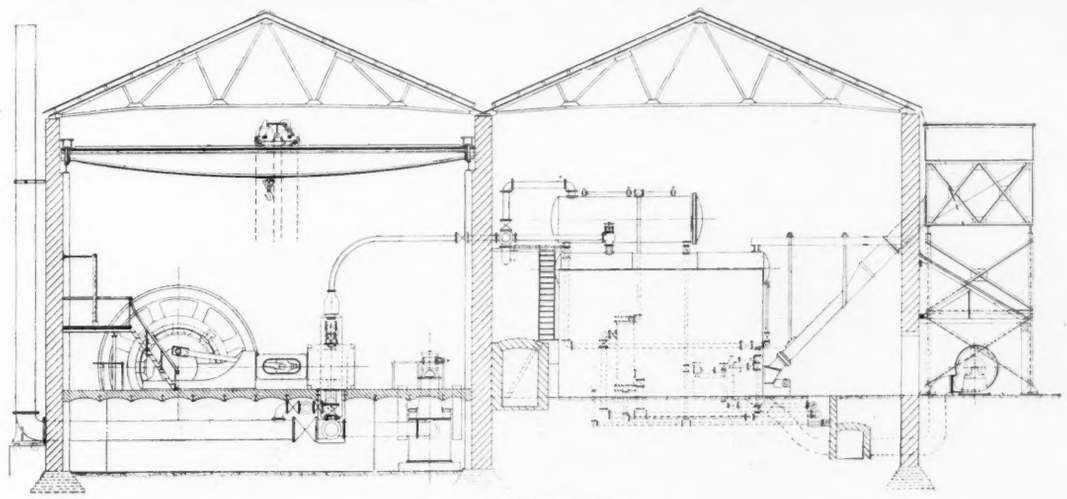
Interior of Boiler House Showing Coal Chutes and Mechanical Stokers.

The journal shells are in four parts, two side, one top and one bottom part, with adjustments for taking up any wear. The shells are lined with Babbitt metal, expanded in place, and bored and scraped to fit the shaft.

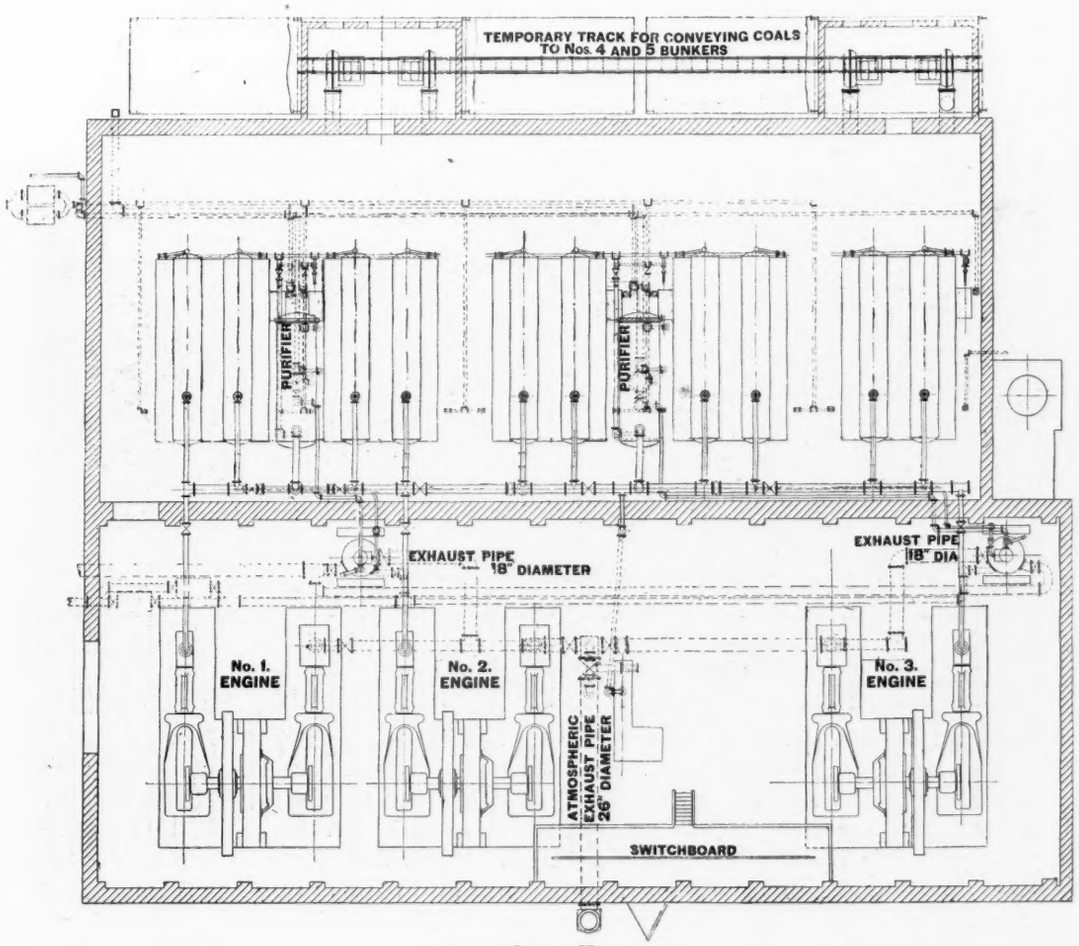
The ends of the slide are bolted into the cylinder and frame. The portion traversed by the crosshead is bored.

The connecting rods are of forged steel with solid ends. The journal boxes for the crank and crosshead pins are of bronze, the former being lined with Babbitt metal, adjusted by means of wedge blocks and locking bolts. The crank pin measures 5 inches by 5 inches.

The crankshaft is 17 inches diameter through the wheel



Section of Power House.



Plan of Power House.

This reduces the chance of hot journals, for it allows the crosshead to travel in any path required by the crank pin should the engine from any cause get out of line. The crosshead is of cast-iron, furnished with Babbitt-faced removable and adjustable shoes turned and scraped to fit the bored slide. The crosshead pin measures 5 inches by 5 inches.

hub and generator and 15 inches diameter elsewhere. The journals are 15 inches diameter by 26 inches long. The cranks are disc pattern pressed and keyed on to the shaft.

The diameter of the fly-wheel is 18 feet, and it weighs 40,000 lbs.

The pistons are of cast-iron, heavily ribbed inside, and are provided with followers, bull and packing rings.

The piston rods are of steel, secured to the crosshead by a thread and jamb nut.

The two horizontal cross-compound engines are arranged side by side in the engine room, with a vertical Allis jet condenser placed behind the cylinders and below the level of the engine room floor. The latter consists of an air pump of 32 inches diameter and 12-inch stroke, working vertically in a condensing chamber. The steam cylinder is mounted directly above the latter and connected directly with the air pump rod. Rigidity is ensured by a heavy cast-iron guide and a large crosshead. In order to permit of using the steam expansively, connecting rod, crank and heavy fly-wheels are fitted. The steam cylinder is provided with a form of Corliss valve. The working speed is approximately 50 revolutions per minute.

Coal Bins and Crane.

The arrangement of exhaust piping is such that either engine may exhaust independently into the condenser, or to the atmosphere, as desired. The exhaust to atmosphere is effected through a back pressure balanced valve, so adjusted as to open to full bore immediately the pressure of the exhaust steam rises in the piping above the atmospheric pressure.

The injection water is drawn from the canal running alongside the power house, the intake being arranged with a wrought-iron grid and strainer, preventing the passage of refuse to the pumps. The intake is further so arranged, that the chamber containing the valve and strainer can easily be cut off from the canal if it is desired to do so for cleaning.

In order to further ensure that no refuse enters the air pump with the injection water, a mud box with removable strainer plates has been fitted in the basement of the engine room; this box is so arranged that it can be opened and cleaned with the greatest ease.

The discharge from the air pump is taken into the canal at a point some feet distant from the intake.

The boilers at present installed are six in number, arranged in three batteries, and are of Messrs. Babcock & Wilcox's make; each boiler has a heating surface of 1,790 square feet, and is provided with a superheater.

Steam Mains in Boiler House and "Hoppes" Purifier.

The steam piping is of lap-welded mild steel, provided with cast-iron flanges screwed on. The tees and crosses are also of cast-iron of heavy section. The diameter of the branch pipes connecting the boilers with the main steam header is 7

inches the diameter of the main steam header 12 inches and 8 inches, and the diameter of branches to engines 6 inches; the latter are connected to steam separators mounted immediately above the throttle valves of the engines. In order to ensure sufficient latitude for examination, three expansion boxes of the bellows type have been provided. These latter are made from hard drawn copper hammered into shape.

All the main steam piping is supported from wrought-iron brackets provided with adjustable slings so as to allow the pipes to move freely in certain directions; stays are also provided at suitable points to check vibration.

In order to admit of ready access to the valves and joints of the main steam piping, wrought-iron open work platforms have been fitted immediately beneath them.

The boilers are fitted with underfed mechanical stokers supplied with forced draught from two electrically-driven fans. These latter are installed in a small building outside the boiler house and draw their air from outside. They discharge directly into a system of air ducts constructed under the floor of the boiler room and provided with valves to control the draught. Provision has also been made in the air ducts to prevent the accumulation of gas should the plant be stopped for a short time.

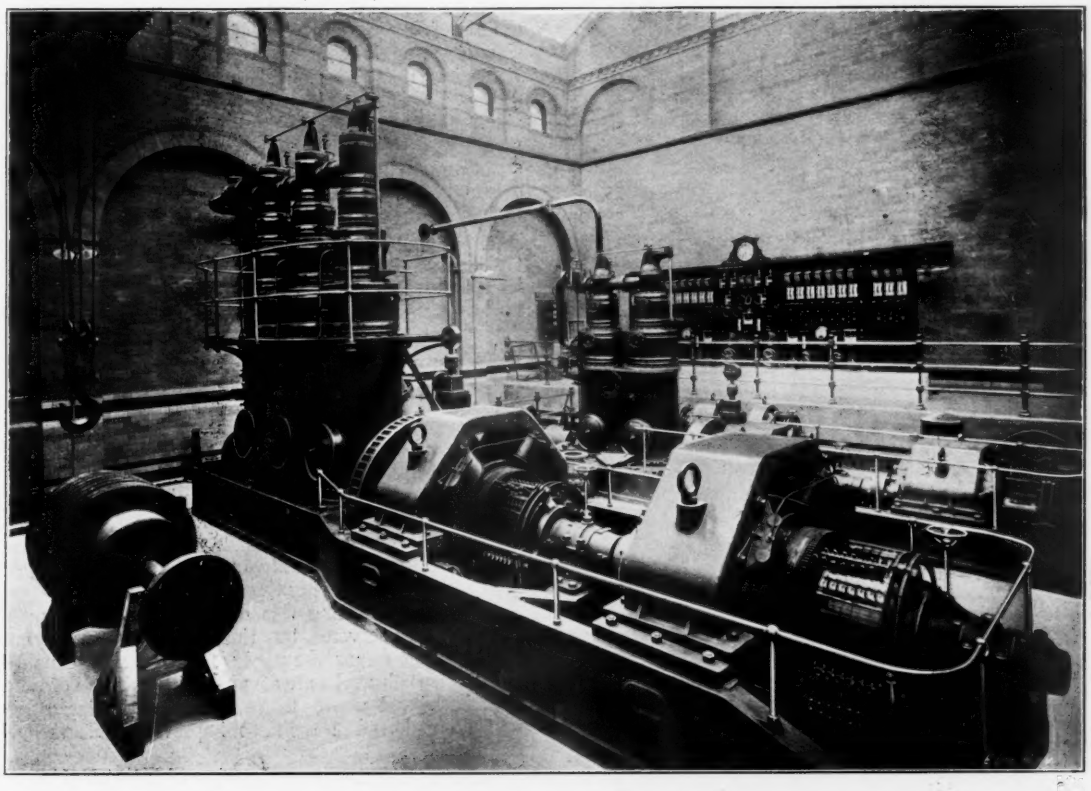
The delivery from the feed pumps is led through a feed water heater of the vertical type arranged to take the exhaust steam from the feed pumps and the condenser. The steam from these latter can, if desired, be exhausted directly to the atmosphere by means of a bye pass.

The delivery from the feed water heater is taken directly into a "Hoppes" purifier mounted above the boilers. In this apparatus the entering feed water is met by live steam from the boilers, and trickles slowly over a large number of shallow metal trays, and deposits the impurities held in solution in the form of rough hard scale on the under side of the trays. The front of the purifier is fitted with a door easily removable, and the trays or pans can be taken out, cleaned and returned with a very small expenditure of labour.

The purified water collected at the bottom of the apparatus gravitates directly into the feed main in front of the boiler which is in communication with the check valves.

In addition to the feed pumps each battery is provided with an injector coupled directly between the main suction piping and the feed delivery main.

The two Crocker-Wheeler generators at present installed are connected to a switchboard mounted upon a platform



Rathmines Electricity Works.—General View of Engine Room.

The store of coal is contained in a series of wrought-iron bins built against the side of the boiler house and supported by wrought-iron columns well brased. Each bin is fitted with a chute of rectangular cross-section and communicates directly with the corresponding hopper of the mechanical stoker. The angle of the floor of the bins and chutes has been so proportioned that the supply of coal gravitates without any manual labour being expended in trimming.

The coal bins are fed by a crane alongside, which takes the coal from railway trucks by means of a discharging grab, and being of long radius is capable of serving any of the bins.

Each battery of boilers is provided with a direct acting duplex feed pump, having externally packed plungers. The arrangement of connections is as follows :—

The suction from each pump is connected to a main communicating either directly with the canal or with a well, valves being fitted to permit of either being used as desired. In the former case the water comes through an efficient straining box.

supported on cast-iron columns at a height of 8 feet above the engine room floor. All the electrical connections are made at the back of board which is placed so as to allow sufficient room for examination of the connections, &c.

The arrangement consists of two generators, four feeder and two lighting panels. Each generator panel is fitted with a shunt ammeter, main circuit breaker, two single-pole main switches, voltmeter plugs, shunt rheostat and lightning arrester. Each feeder panel is provided with an ammeter, circuit breaker and two single-pole switches.

The lighting panels are complete with ammeters, switches, and fuses for four main circuits.

The distribution of the energy to the various parts of the extensive works is effected by triple braid weatherproof conductors mounted on special insulators and carried on wooden poles with cross-arms entirely overhead. The four main power circuits are terminated on distributing boards placed at convenient points, and the current is further distributed to upwards of 30 motors, ranging in power from 5 to 100 horse. These motors are employed in the various opera-

tions of crushing, grinding, briquette making, driving, hoists, revolving furnaces, fans, blowers, and pumps, &c. The total amount of main cable used approximates to a length of five miles.

The current is also used to operate a large Temperley transporter on the side of the Manchester Ship Canal, and in order to permit of the tower being moved along the side of quay as required, the current is led to the machinery by flexible cable connected to especially designed plug switches, which can be put in circuit at a number of points along the quay.

The lighting of the works is provided for by a number of enclosed and open arc lamps, and incandescent lamps.

Rathmines Electricity Works.—Incandescent Lamp Post.

The whole contract has been carried out by Messrs. Robert W. Blackwell & Co., Limited, and at the present moment a third engine and generator, and a second jet condenser, in all respects similar to the existing ones, are being built, and will shortly be installed.

The ores are originally brought by the Ship Canal alongside the corporation's wharf, where at all times there is 26 feet of water, and the wharf is suitable for operating vessels of 5,000 tons. The ore is discharged at this point by a Temperley transporter capable of discharging 60 to 80 tons per hour, worked by a 35-H.P. motor. The transporter delivers the ore into the crushing plant adjoining the wharf. This plant has a capacity of 90 to a 100 tons a day, and is worked by a 100-H.P. motor. It was built by the Gates Ironworks, of Chicago, and is so fitted with elevators and transporters that the ore after being crushed is automatically moved to the ore bins adjoining. Thence the ore is hauled to the calcining department, where 10 calciners are erected of the revolving table type invented by Godfrey, of Swansea.

The roof of these calciners is fixed but the floor revolves. There is an open sector in the roof where the ploughs are fixed. These ploughs stir the ore as it moves against them, and, being in the open air, are kept cool, and the oxidising advantage of cool air fully obtained. The grate is attached to the calciner at one side of the open sector, gases pass round the furnace and out at the flue on the other side of the opening, and thence to the dust chambers and big stack. The roof is low to bring the heat of the gases effectively to the ore. Each pair of calciners is driven by a small motor absorbing 3 H.P. After calcination the ore is briquetted: two White mineral presses, made by Chisholm, Boyd & White, have been erected, and through these machines the calcined ore and fluxes are all passed. The cupola is of the steel jacketted type, made by Fraser and Chalmers, of London. It is 18 feet high and 140 inches by 42 inches at the tuyers.

At present the corporation do not desilverise the bullion that is obtained from the cupola. Slag is tapped at each end, and, after passing through settling pots, runs into the usual conical moulds, and is taken thence to the zinc department. The blower was made by the Connersville Company, and is driven by a 100-H.P. motor. The pressure of air varies from $1\frac{1}{2}$ to $1\frac{3}{4}$ lbs. During the last two months 2,500 tons of Broken Hill slimes have been smelted; more than 90 per cent. of the lead and 80 per cent. of the silver are recovered in the bullion, the remaining 20 per cent. of the silver passing into the zinc slags, and being recovered in the zinc department. Following now the zinc slags we come to the Siemens furnaces, which have been specially built for oxidising the zinc. They are of the latest steel-making character, but modified considerably in the flues and regenerators, so as to avoid being choked up by the large quantities of zinc oxide driven off. The slags are mixed with a small quantity of fuel, and the heat of the Siemens furnace does the rest.

The oxide fumes, after passing through the regenerators, are taken through cooling towers, and then into dust flues. The flues are so arranged, that by means of baffles and pockets the dust is caught to a very considerable extent. The slag remaining in the furnace is then tapped into a large 20-ton ladle, where it settles into a heavy material called matte, and a lighter material, which is the worthless slag, and is thrown away. The matte, however, which is about a quarter of the whole, is found to contain the bulk of the silver that was in the slags and any of the zinc that has not been driven off as oxide.

This matte is weathered and crushed, calcined to drive off sulphur, and then mixed with the ore, briquetted and smelted. It is specially valuable as an addition to the ore, for it has, owing to its contents of iron and soda, a specially good influence in keeping the furnace open.

Of the zinc entering this department, about 70 per cent. is now being recovered, but the corporation considers that this is by no means the whole of what will be caught later on. The whole works are supplied with a system of railways, both broad and narrow gauge, and labour-saving appliances have been adopted of the most improved kinds throughout the establishment.

The corporation, in conjunction with the United Alkali Company, is working out a very interesting method of recovering the zinc from the zinc oxide by means of electrolysis. Preliminary experiments on a fairly large scale have been most satisfactory, and steps are now being taken to carry out a thoroughly commercial test. The results of this will be of great interest in the metallurgical and electrical worlds.

We have to thank Mr. Dawson for the great assistance he has rendered us in compiling this exhaustive description of a remarkable undertaking.

RATHMINES ELECTRICITY WORKS.

The question of providing a supply of electricity for Rathmines, near Dublin, first received practical attention in 1895, when, principally owing to the exertions of the late Mr. S. H. Bolton, J.P., a special committee was appointed to consider the advisability of establishing a municipal service.

It was the general feeling that the work should be undertaken by the local authority—then the Rathmines and Rathgar Improvement Commissioners—and as a first step

towards the realisation of the project the Commissioners authorised the committee to make application to the Board of Trade for a provisional order under the Electric Lighting Acts. The result was the granting of the Rathmines and Rathgar Township Electric Lighting Order in 1896, the Royal assent to the confirmatory Act being accorded on July 20th of that year.

In the meantime the Commissioners had consulted Mr. Robert Hammond, of Westminster, as to the best means of fulfilling their statutory obligations under their order, and in July, 1898, Mr. Hammond was authorised to prepare the necessary plans and specifications for the generating works and mains. Tenders for the various sections of the work were publicly invited in the following year; these were carefully examined by the Committee, and on their recommendation the Council gave out the contracts as follows:—

Particulars.	Names of contractors.
Boiler-house plant	R. Taylor & Sons, Marsden, Yorks.
Engine-house plant	Mather & Platt, Limited, Manchester.
Pipe work	J. Spencer, Ltd., Wednesbury.
Condensing plant	Wheeler Condenser and Engineering Co., U.S.A.
Water cooling plant	Klein Engineering Company, Ltd., Manchester.
Travelling crane	Higginbottom & Mannock, Manchester.
Switchboard and testing instruments	James White, Glasgow.
Battery of accumulators ...	Tudor Accumulator Company, Ltd., London.
Supply mains:	
Insulated cables and trench work	British Insulated Wire Company, Ltd., Prescot.
House meters	S. Z. de Ferranti, Limited, Hollinwood.
Public lighting:	
Arc lamps	Veritys, Ltd., Birmingham.
Incandescent lamps	General Electric Company, Ltd., London.
Buildings	J. Donovan, Dublin.

The direct current three-wire system is employed, energy being supplied to consumers at a standard pressure of 220 volts for lighting and for small motors, and 440 volts for motors requiring more than 5 KW.

The generating works are situated in a convenient central position on the Council's land at the rear of the Town Hall, where adequate space for extension is available.

The buildings form a substantial structure of brick and stone, and comprise engine and boiler houses, battery and test rooms, engineers' offices, stores and workshops. The engine house is 37 feet wide, the length from the wall at the back of the switchboard to the temporary end being 48 feet. Parallel with it is the boiler house, and on the opposite side are the workshops and the chief assistant's office. The battery room, test room, and general offices form the front part of the group.

The steam generating plant comprises three Lancashire boilers, each 30 feet long and 8 feet in diameter, made by Messrs. Robert Taylor & Sons, of Marsden, and fitted with Vicars' mechanical stokers. They are constructed of six rings of mild steel, and have an evaporating capacity of 7,000 lbs. of water per hour at a pressure of 160 lbs. per square inch with the feed water at 60° F. The flue dampers are handled from the boiler front by means of counterweights sliding in guides, which are calibrated to show the extent of the opening. The whole of the safety fittings, valves and gauges were supplied by Messrs. Hopkinson. The lagging of the boilers with fossil meal, to a depth of 3 inches, was undertaken by Messrs. Haacke & Co.

A double ram steam pump by Green, a Holden & Brookes injector, and an electric combination consisting of a Lundell motor with a three-throw single-acting pump by Blake and Knowles, are provided to deal with the feed water.

The steam and feed pipes are of lap-welded steel, the latter galvanised, and the lagging is of sectional magnesia covering. The pipe work, including the erection of the cast-iron feed tank and the feed water heater, was carried out by Messrs. John Spencer, Limited, of Wednesbury.

A Green's economiser, containing 96 tubes, has been erected in a bye-pass from the main flue between the boilers and the chimney stack; the scrapers of the economiser and the mechanical stokers are operated through belting by an ironclad 6-B.H.P. Crompton motor.

In the engine house there are two generating sets, one of 300 KW. capacity, and the other of 150 KW., the two being capable of supplying electrical energy for about 22,500 lamps fixed on consumers' premises. With the aid of the accumulators about 30,000 lamps could be dealt with.

Each set consists of a pair of four-pole Mather & Platt dynamos driven by a Willans central valve engine. The larger engine has three cranks and nine cylinders and runs at 320 revolutions per minute. The smaller engine has two cranks and four cylinders, and runs at a speed of 360 revolutions per minute, the working steam pressure being 150 lbs. to the square inch.

Arc Lamp Post.

A steam separator is fitted to each engine, and the lubrication is effected automatically. The guaranteed steam consumption at full load when running condensing is 24½ lbs. per kilowatt-hour for the 300 KW., and 29 lbs. for the 150 KW. set.

A Mather & Platt motor-generator is provided for charging the regulating cells of the battery of accumulators.

A jet condenser with a steam-driven direct-acting pump has been fitted in the cellar by the Wheeler Condenser and Engineering Company. It maintains a vacuum of 26 inches, and raises the water to the top of a Klein cooling tower, in which it is reduced in temperature by about 30° F. This tower cooler uses natural draught, and is able to deal with 40,000 gallons per hour.

The engine room is traversed by a 10-ton crane, supplied by Messrs. Higginbottom & Mannock, of Manchester.

The switchboard, surmounted by an electrically wound clock, is situated on a platform at the end of the engine room, and stands upon a plinth of glazed bricks, 18 inches high. Its length is about 17 feet. The board is divided vertically into three panels, the arrangement being the usual

one of outers to left and right, neutral and battery regulators in the centre.

Provision has been made on the outside panels for four dynamos and for nine three-wire feeders, also for the main circuit of the battery. The centre panel carries the electrostatic voltmeters for the "pilots" and battery, together with the ammeters for the "neutral" and the earth mains, and a protective device to short circuit the earth current recorder.

In each dynamo circuit is a minimum cut-out, an ammeter, a two-way switch and fuse and a shunt regulating switch. One polarised voltmeter serves each pair of dynamos.

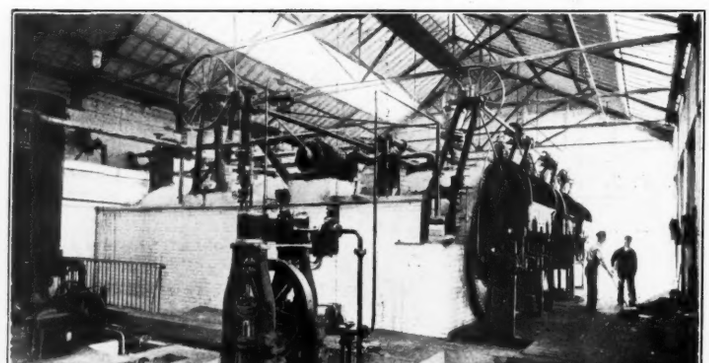
Each feeder has two ammeters with duplex switches and fuses fixed on the upper half of the outer panels. A chamber below the switchboard contains the neutral bar and the registering watt-hour meters on Aron's three-wire system.

The battery is arranged to be charged by the booster in conjunction with the generators. A multiple contact switch for regulating the supply when taken from the accumulators is situated in the accumulator room, and is operated through rods and chain gear from hand wheels fixed at the bottom of the centre panel of the switchboard.

The booster gear consists of an ammeter and double-pole two-way switch and fuse, with a starting switch for the motor side. A Crawley automatic switch protects the dynamo of the booster, and a double shunt regulator permits of the insertion of a variable resistance into the field magnet circuits.

Messrs. J. White, of Glasgow, erected and connected up the board and made all the apparatus thereon, excepting only the watt-hour meters.

The battery consists of 274 Tudor cells, each cell consisting of six positive and seven negative plates in a lead box. They are arranged in two tiers upon stout oak frames, which are protected from acid spray by a coating of special paint.



Boilers and Feed Pumps.

Forty-nine cells on each side of the neutral serve as regulators, and are connected in steps to the stops on the regulating switch by bare copper rods.

The battery is capable of discharging at 80 amperes for 10 hours with a terminal pressure of 500 volts. The normal and maximum rates are 120 and 150 amperes on "charge," and 80 to 216 on "discharge."

The whole of the work connected with the manufacture and laying of the cables has been carried out by the British Insulated Wire Company. The "solid system" has been adopted, all the feeder and distributor cables being triple concentric, paper insulated and lead sheathed. They are laid in cast-iron troughing, filled in solid with pitch tempered with resin oil.

For the distributing network ·10 and ·05 square inch cables have been laid, the outer conductor forming the "neutral" of the three-wire system. There are at present seven feeders comprising ·4 and ·3 square inch cables.

For the public are lamps 7/16 single cables are used, while concentric cables are employed for the incandescent street lamps and for house connections.

Altogether, 45 miles of cables have been laid. This does not include the pilot wires, which are laid in the same troughs as the feeders.

The insertion of cast-iron junction boxes at numerous points facilitates the isolation of any section of the distributing network either for repair or for making connections.

Arc lamps to the number of 108 have been fixed in the principal thoroughfares, spaced about 65 yards apart, and carried at a height of 18 feet from the roadway by cast-iron pillars, with an ornamental curved bracket of wrought-iron construction. The lamps were made by Messrs. Veritys, and the posts by James Allen, sen., & Sons. The arc lamps are run in 12 series of nine lamps each, connected across the outers of the distributors. The extinguishing of one or more lamps will not affect the remainder, as an automatic switch is provided to substitute a wire resistance for the lamp. The terminal lamps on each series are fitted with single-pole switches and fuses, all the lamps being provided with substitutional switches. A lowering gear enables trimming operations to be carried out from the roadway.

Lighter and shorter posts, 230 in number, each bearing a two-arm bracket carrying a pair of glow lamps, deal with the lighting of the quieter streets. These were cast by Macfarlane & Co., and were fitted up and erected by the General Electric Co., of London. They are connected through a switch and fuse in the base to the distributing network.

With the object of placing the supply at the disposal of all classes of consumers the Council has decided to charge 6d. per Board of Trade unit for private lighting, and 3d. per unit for power and heating. A discount of 5 per cent. is allowed off the above-named figures, which brings down the prices approximately to 5¾d. per unit for lighting, and 2⅞d. per unit for power.

It is generally accepted that one unit of electricity is equivalent, light for light, to a little more than ⅛th of 1,000 feet of gas, so that electricity at the net price of 5¾d. per unit charged by the Rathmines Council for lighting can be obtained at practically the same cost as gas, the price of the latter being 3s. 8d. per 1,000 cubic feet.

For the benefit of those consumers who do not care to expend the necessary capital in installing the wires and fittings in their premises, the Committee has adopted the "free wiring" scheme of the National Electric Company, of London, charging by way of rental for the wires and fittings, the sum of 1d. for every unit used, in addition to the ordinary charges made for the electrical energy supplied. This method of charging, as we have pointed out before, is open to severe criticism, as it directly tends to keep down the consumption of energy, and taxes most heavily the most desirable consumers. It would be far more equitable to charge a fixed rental per lamp installed.

The area of supply constitutes the whole of the district of Rathmines and Rathgar; the mains have been laid throughout the principal streets, and extensions to the other parts of the district have already been decided upon. The contract will shortly be given out for the probable requirements over the next three years; the Council will then be able to lay down the mains in any other street where the demand is likely to yield a reasonable return on the capital expenditure on that section of the mains.

At present there are about 1,160 lamps of 8 c.p. connected to the mains, while applications for a further 3,050 lamps are in hand. In addition to these the public lighting represents about 2,540 8-c.p. lamps, the total demand thus being equivalent to 6,750 lamps. A temporary supply has been given for the past month free of charge.

The capital cost of the generating works, mains, and public lamps amounts to about £71,000.

The whole of the works have been carried out under the

supervision of Mr. Robert Hammond, the consulting engineer. Mr. G. F. Pilditch, who has acted as clerk of the works for Mr. Hammond, is now the resident electrical engineer, Mr. S. T. Land being his chief assistant.

BUSINESS NOTES.

(*Continued from page* 420.)

Address.—Messrs. Heaton & Smith, Limited, of Salford, have opened showrooms in London at 1, Holborn Circus.

Books Received.—"Les Décharges Electriques dans les Gaz," translated from the English of J. J. Thomson by Louis Barbillion. Paris: Gauthier-Villars. 1900. 5 francs.

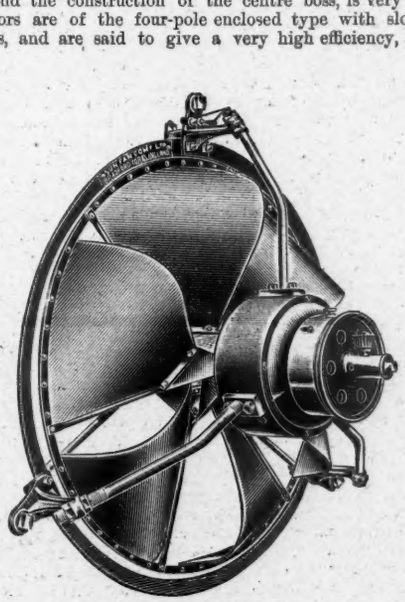
"Annalen der Physik," (fourth series). Vol. 3, No. 9. Leipzig: J. A. Barth. 1900.

"Construction of Large Induction Coils." A. T. Hare. London: Methuen & Co. 1900.

Campbell Gas Engines.—A gold medal has been awarded to the Campbell Gas Engine Company, Limited, for their exhibit of gas and oil engines at the Paris Exhibition, and seven members of their staff, foremen and workmen, have been awarded silver and bronze medals for the work which they have done in connection with the exhibit.

Direct Reading Ohmmeter.—A cheap and efficient portable instrument for the rapid measurement of resistances, which is simple enough to be understood and used by workmen, has lately been brought out by Messrs. Jas. Hartley & Co., of Manchester. The instrument is based on the slide-wire bridge principle, but instead of using a galvanometer, a telephone is employed as in the Kohlrausch bridge for determining the position of balance. There are four direct reading scales, differently coloured, each brought into use by inserting a plug in a socket of corresponding colour; by this means a wide range is obtained. Instead of having a sliding key, contact with the slide wire is made with a stylus, which is held in the hand. The battery is enclosed within the case of the instrument, and, so far as we can gather from the description furnished to us, no induction coil is used, the click heard in the telephone at the moment of contact being sufficient to indicate want of balance. The overall dimensions of the apparatus are 17 inches × 5 inches × 4½ inches, and it weighs 7½ lbs.

Electric Fan.—The Sun Fan Factory, Limited, of Bradford, are introducing a combination of their well-known "Sun" fan with an electric motor, directly connected to the fan-shaft, as shown on the illustration herewith. As will be seen, the motor is of the enclosed type with doors over the commutator, which can be opened for access to the brushes. The whole combination is very neat, light, and compact, owing to the fact that the entire framework carrying the combination is of wrought-iron, giving great lightness and strength compared with the ordinary cast-iron framework. The fan itself, owing to the special form and depth of the blades, and the construction of the centre boss, is very efficient. The motors are of the four-pole enclosed type with slot-wound armatures, and are said to give a very high efficiency, a typical



result being that a 30-inch fan motor at 700 revolutions moves 10,000 cubic feet of air per minute with a consumption of 800 watts. The leads to the motor are led through one of the arms, which is hollow, and are thus protected from the danger of fouling the fan. Another special point is, that the journal in front of the fan, which takes the thrust when the fan is working, is fitted with a screwed plug in the end, between which and the shaft are two discs to reduce friction. This makes the bearing adjustable end way, and also gives immediate access to it if required. The whole combination has been designed as the result of long experience, to give the highest efficiency compatible with durability and steady constant running.

Electric Trucks.—The McGuire Manufacturing Company, of Chicago, said to be the oldest and one of the best known electric truck manufacturers in the United States, inform us that they are about to establish a factory in Great Britain. They have opened branch offices at 5, Warwick Court, High Holborn, where any information concerning their line can be obtained. Pending the establishment of a factory in this country, orders will be supplied from the Chicago works. We understand that the company have supplied their trucks to over 300 of the leading railways in Europe and America.

Fined under the Factory Act.—The St. Helens Cable Company, Limited, were summoned some days ago at the Warrington Police Court, before the Mayor (Ald. Roberts) and other magistrates, that on July 5th, being the occupiers of a factory under the meaning of the Factory and Workshops Act, 1878, they failed to fence certain machinery in a certain room, wherewith Elizabeth Allen was killed. They were further charged that on June 3rd, being Sunday, they employed eight young women. The defendants pleaded guilty. Major Roe, factory inspector, prosecuted.

Mr. Heyl-Dia, managing director of the works, said the shafting had only been coupled a few days previously for the purpose of experimenting. No machines were on the table for about 30 yards, but there was some shafting revolving underneath. No girl had any business to be in that part of the room. In due time the whole of the shafting would be protected. It had been coupled without orders.

Mr. Oulton said the directors wished to express their deep regret at the committal of the offence, but said the company were a new company, and at the time of the accident had not got their place into proper working order. They were gradually doing so, and were now in very good order. The shafting had been connected but a few days, and that without the knowledge of the directors.

The Bench accepted Mr. Oulton's statement with regard to the ignorance of the directors of the committal of the offence, but owing to its serious nature, they inflicted a fine of £20 and costs in the first charge, and £1 and costs on each of the other eight charges.

Fire.—On the morning of 6th inst. some electric wires fused in a chamber beneath the lift well at the Bank station of the City and South London Railway. A slight fire occurred. The Bank station is situated under St. Mary Woolnoth Church.

Lift Accident.—A fatal accident occurred at the London Bridge station of the City and South London Railway last week. While one of the electric lifts was being tested, H. A. S. Judge, an electrician's mate, attempted to climb out of the well and was crushed by the descending cage. At the inquest a verdict of "Accidental death" was returned.

Track Joints and Bonds.—Mr. W. E. Kenway sends us an illustrated description of his new "Victor" rail joint, and "Victor" bond for electric tramways. The former is made with fish-plates of an angle-iron section, bolted both horizontally and vertically, and so shaped as to give the maximum resistance to both the bending and the twisting moments at the joint. A double steel bolt, of which the two shanks are united by a stout bar, passes through notches cut in the ends of the rails, and through the centre holes of the fish-plates, so as to give additional strength at the weakest point. The bond consists of two flat, somewhat S-shaped slitted bars exactly alike, each provided with a plug at each end. The plug at one end is about 1 inch in diameter outside, and is pierced with a taper hole; the other plug is coned outside to fit into this taper, and is pierced with a hole about ¼ inch diameter. Placing the two parts of the bond, one in either side of the web of the rail, with the plugs reversed, the larger plugs enter the holes prepared in the web, and the smaller plugs fit into the larger ones. A steel drift pin is then driven into the small holes, expanding all the parts into intimate contact with each other, and with the rails. The bonds are short, and are entirely covered by the fish-plates.

Trade Announcements.—Mr. Alph Steiger has removed from 16, Mincing Lane, E.C., to 28, Victoria Street, Westminster, S.W. As representative of Messrs. Escher, Wyss & Co., of Zurich, Switzerland, Mr. Steiger has received the order for the complete hydraulic plant to be erected on the Cauvery Falls, in India, by the Government of Mysore. The plant will develop 7,800 H.P., and will be used for a large electrical transmission plant.

The offices of the City and South London Railway have been removed to 71, Finsbury Pavement, E.C., over the company's Moorgate Street station.

Messrs. Walker & Hodgetts, electrical engineers, have removed to more extensive works at St. Simon's Electrical Works, Salford, Manchester.

ELECTRIC LIGHT AND POWER NOTES.

Aberdeen.—The Gas and Electric Lighting Committee of the Town Council agreed last week to increase the salary of the electrical engineer by the amount of £50 per annum, by annual increments, until it reaches £500. The present salary is £300.

principal thoroughfares, spaced about 65 yards apart, and

The whole of the works have been carried out under the

Alnwick.—The District Council has consented to support the application of the Northern Counties Electricity Supply Association for a provisional order.

Batley.—The estimates of the cost of the proposed electricity works have been revised by the engineers and raised from £22,231 to £25,602. An application is to be made to the Local Government Board for leave to borrow this amount.

Bradford.—The Board of Guardians, having failed to make satisfactory arrangements with the Corporation for the supply of electric light, has obtained authority to borrow £6,500 for the purposes of its own installation, and has let the contracts. The installation is for 1,200 lights.

Brazil.—The Société Anonyme du Gaz de Rio de Janeiro, a Belgian company, with offices at Rio de Janeiro, has secured an extension of its privilege for lighting that city by gas to the year 1940 and by electricity to 1915. The distribution of electric current is to be subterranean and the system of lighting to be by arc lamps. A good deal of new machinery and equipment is to be added to existing plants for the purpose.

Carnoustie.—The Burgh Commissioners have been advised by Mr. W. T. Purvis, Edinburgh, to proceed with their application for powers to supply electric lighting for the burgh, and then transfer their order to Messrs. Crompton & Co., of London, who would bind themselves to erect works, and vend electricity within the burgh, according to a stipulated scale.

Cheltenham.—The electrical engineer is considering the tenders for coal. The lowest tender is stated to be 150 per cent. higher than two years ago. He has also recently prepared a detailed estimate of the cost of certain electric lighting extension works necessary. He puts it at £6,000. The work in connection with Mr. Nevins's electric tram scheme is to be commenced this month.

Cowes.—The Board of Trade has consented to allow the District Council's provisional order to remain in force for 12 months longer, but insists on steps being taken under it during that period.

Dudley.—The annual financial statement of the borough accountant shows that the liabilities on electrical supply account amounted at the end of March to £7,755, including £2,122 for buildings, £3,496 for machinery, and £511 for engineers' fees. The first amount received from the tramway company for current supplied for nine months amounted to £844 16s. 2d., the quantity consumed by the company being 101,377 units, at 2d. per unit. Payments only are shown, because it was impossible to include a proper income and expenditure account and balance-sheet for the year owing to the price per unit for current supplied to the tramway company not having been fixed by the Board of Trade. The matter has been settled now, however, and the first amount received, as stated above. It may be added that the Corporation will supply all the tramways within the borough with current, and as there are three other lines shortly to be started, as well as the electric lighting of the town, there ought to be in the near future a substantial income from the supply of electric current.

Electro-Chemistry.—A great centre of electro-chemical industry (says the *Engineer*) is springing up in Sault St. Marie, both on the American side and on the Canadian side. A company with £6,000,000 capital has been organised for the development of the water-power here. Ten thousand horse-power are to be taken by the American Alkali Works; 14,000 H.P. are already utilised on the Canadian side in making paper pulp. There are also nickle reduction works and chemical works, and other enterprises are in contemplation.

Felling.—The District Council has resolved to apply to the Board of Trade for a provisional order for the supply of electricity in the district.

Glasgow.—One of the most complete installations of electric light in this country has been introduced into the Ruchill Fever Hospital, erected by the Glasgow Corporation. There are no fewer than 4,000 electric lamps in the building and grounds. For six years the hospital has been in course of construction, and the cost exceeds £250,000. More than a thousand persons will be under the roof of the hospital when it is in full working order.

Gosport.—The Electric Power Distribution Company have submitted to the District Council proposals for dealing with the electric lighting order granted to the Council, and also with the tramways in the district. The company would undertake all the obligations of the order upon special terms as to the price to be charged for the public and private lighting, with an option to the Council to acquire the undertaking at stated periods at a valuation in the usual way. As to the tramways, the Council would, in the first instance, have to give notice to the Gosport Street Tramway Company under Section 43 of the Tramways Act, 1870. The company intimate that they have arranged with the British Electric Traction Company to assist them in dealing with the tramway portion of the proposal.

Hampstead.—The report on the Vestry's electrical undertaking, just issued, states that the capital outlay since the commencement of the undertaking five years ago has been £162,212. The total receipts for the year amount to £30,661, an increase of £6,283 on the previous year. The gross profit amounted to £16,325, of which the repayment of loans and interest absorbed £6,619. The total net profit since the commencement of the undertaking has been £20,586.

Inverness.—The North of Scotland Electric Light and Power Company, Limited, has proposed that the Town Council's order for electric lighting be transferred to the company on terms to be arranged.

Leeds.—The City Council has resolved to abolish electricity meter rents on October 1st.

Leigh.—The Gas, Water and Electricity Committee of the Town Council have resolved that electricity supplied to any of the departments of the Corporation be charged for at the uniform rate of 3d. per unit. In consequence of an agitation amongst the local tradesmen against the conditions of supply, it has been decided to give consumers of electricity the option of purchasing current for lighting purposes either on the maximum demand indicator system, as at present in force, or at a uniform price of 5d. per Board of Trade unit.

London.—St. Pancras.—It is perhaps due to the impending transformation of the St. Pancras Vestry into a borough council in November, and the desire to bring the final statement under the old *régime* up to date, that the chairman of the Electricity and Public Lighting Committee has delayed until now the issue of his report for the past year. As it is the report of Dr. W. Smith (the chairman) covers a period extending from May, 1899, to September, 1900. It points out that during that time a great advance has been made in the undertaking which has necessitated the carrying out of important extensions, although the difficulty of obtaining new plant has caused great anxiety to the committee and the staff. New consumers have been connected to the mains representing an extra demand for supply to 11,305 16-C.P. glow lamps, 106 arc lamps, and 25 motors equal to 89 H.P. The accounts for 1899 (which have already been reviewed in these columns), show a net profit of £6,842, which with £1,892 brought forward from 1898, make a total of £8,734 available for disposal. Of this sum £1,600 has been written off for depreciation of accumulators, meters and switches; £2,000 has been placed as a contribution towards the lighting rate; £4,000 transferred to the reserve fund, and £1,134 carried forward to the next account. During the period from 1892 to 1899 the total revenue amounted to £205,452, and the trading expenditure to £128,501, whilst £58,662 has been devoted to the repayment of capital and interest. The total profit of £18,288 from the commencement of the undertaking has been distributed as follows:—Preliminary expenses written off, £554; depreciation, £1,600; contributions to lighting rate in lieu of further reduction in price, £3,000; reserve fund, £12,000; and carried forward £1,134. The capital expenditure per unit sold, which in 1892 was 4s. 1d., now amounts to 2s. 3d. The report mentions that during the year extensive alterations and extensions have been carried out at the Regent's Park station, the additional plant being completed, consisting of four 850-H.P. engines and dynamos, six 500-H.P. dryback marine boilers, condensing plant, feed-water heaters and new switchboards. In the case of the King's Road station the great demand for electricity has necessitated attention being given to the subject of extensions of the buildings, but in consequence of the present Vestry being shortly dissolved it has been considered advisable to postpone the question. In the meantime the electrical engineers has been instructed to consider what action should be taken in the matter. The report states that as the Electricity Committee has decided to carry out most of the extensions of mains by its own workmen without the aid of contractors, the outdoor staff has been considerably increased during the past year or two. In this connection the chairman testifies to the very satisfactory, economical and expeditious manner in which the work has been done under the superintendence of Mr. W. A. Brown, the distributing engineer. During the past 18 months 152 additional arc lamps have been erected in various thoroughfares, bringing the total up to 379 arc lamps. As the lighting of the Prince of Wales Road, Malden Road, and Queen's Crescent by means of the enclosed type of arc lamp has not proved satisfactory, the Committee called upon the contractors to replace the lamps with those of the Brockie-Pell open type, and since the alteration the lamps appear to be satisfactory. Nearly all the arc lamps sanctioned by the Vestry having now been completed, the Committee have ordered a list to be prepared of the streets next to be taken in hand, especially in view of the large increase in the price of gas. The report, which then refers to the recent reductions in the charges for supply for private and public lighting, and states that, as a result, electricity is now cheaper than gas. In conclusion, the Electricity Committee record their satisfaction with the manner in which the work of the department has been carried on by Mr. S. W. Baynes, chief electrical engineer, and Mr. A. E. Pycraft, chief clerk, and the officers of the engineering and clerical staffs respectively, and the Vestry, at the meeting last week, adopted a resolution to that effect.

Victoria Embankment.—The works which are being carried out by the County Council for the lighting of the Embankment with arc lamps are now approaching completion. About 144 500-watt lamps will be distributed over the Embankment and its approaches, and Westminster and Blackfriars Bridges; they will be spaced about 45 yards apart on the edge of the kerb, and will be divided between nine circuits. The generating station adjoins Charing Cross District Railway station. Sir Alex. Binnie is the author of the scheme, with Mr. T. P. Gunyon as superintending engineer.

Shoreditch. — The Vestry has received the County Council's sanction to a loan of £21,905 for Haggerston electricity works.

Nelson.—The Town Council has received the sanction of the Local Government Board to the borrowing of £11,950 for electric lighting purposes.

takes the thrust when the fan is working, is fitted with a screwed plug in the end, between which and the shaft are two discs to

electrical engineer by the amount of £50 per annum, by annual increments, until it reaches £500. The present salary is £300.

Llandaff.—The District Council has resolved to apply for a provisional order for the supply of electricity, and will not empower any company to obtain an order.

Newbury.—The electric lighting provisional order obtained by the Town Council eight years ago, expired on the 22nd ult.

Nuneaton.—The Council has adopted the report of the Electric Committee as follows:—

To take over the undertaking on September 29th next; to accept the tender of Messrs. Babcock & Wilcox for new boilers for about £1,050; to accept the tender of the Hart Accumulator Company for accumulators at £1,063; to accept the tender of Mr. Edward Charrington for switchboard at £391; to accept the offer of Messrs. Clarke, Chapman & Co., for exchanging the existing armature at £63; to accept the tender of the Nuneaton Engineering Company for a travelling crane at £120; to purchase testing instruments at a cost of about £50; to purchase new engine and dynamo at a cost of about £1,900, and to purchase an economiser at a cost of about £390.

Peterborough.—The Corporation are hurrying on their electric light works, and it is expected that the supply will be commenced in about three weeks' time.

Pontefract.—The Council on 5th inst. resolved to apply for a provisional electric lighting order, and to oppose a company.

Saltburn.—The Cleveland and South Durham Assets Company appear to be disposed to sell to the Council their plant, cables, and electric generating station for the electric lighting of Saltburn for £10,000. The Council will consider the matter at its next meeting, but the clerk will in the meantime obtain information re the extent of the plant, number of lights installed, prospective number of lamps, and so on.

Sheffield.—There was a breakdown of the electric light on the Sharrow section on Sunday last at 6.30 p.m., due to some defect in the mains. It was found impossible to locate the seat of the mischief for some time, but the defect was remedied just before 10 o'clock.

Spain.—A company has just been formed, with a capital of £60,000, to be known as La Compania Costmetorá del Salto de Leizarán, to put down a plant to utilise the water-power of the River Leizaran (province of Guipuzcoa) in the generation of electrical energy.

Standish.—The District Council has decided to apply for a provisional order for the supply of electricity in the district.

Swansea.—The Town Council has decided to carry out the "free wiring" of consumers' houses on its own account, without the aid of a company.

Train Lighting in Siberia.—In the course of an interesting article in the *Daily Chronicle* describing a run in the Siberian Express from Moscow to Irkutsk, Mr. Henry Norman states that "behind the locomotive comes a composite car, the forward part being the locked luggage compartment, and the after section being the kitchen. Between the two is the electric light plant, for the entire train, even to the red tail lamps, is lighted by electricity. This plant is an illustration of the enterprise Russian engineers are showing in every direction. Steam is supplied by an ordinary upright boiler, but the dynamo is run by a tiny de Laval steam turbine. The electric plant has not been out of order for a moment since we started, and the train is lighted magnificently."

Yeadon.—The District Council have resolved to apply to the Board of Trade for an extension of the term of the Council's provisional order for electric lighting on the score of the "depressed state of trade" and the undeveloped condition of the town.

ELECTRIC TRACTION NOTES.

Barton.—The Barton Rural District Council decided at their meeting on Wednesday to seek a provisional order for the construction of electric tramways in the township of Clifton, as the only means of getting a complete connection between the towns of Salford on the one hand and Bolton on the other.

Bradford.—The Tramways Committee has recommended tenders for the erection of a tramshed at Thornbury, to cost about £14,000, for acceptance.

Crewe.—The Council last week endorsed the recommendation of the Electric Light Committee to go in for a scheme of electric tramways, to be worked in connection with the electric lighting station.

Halifax.—The Tramways Committee has received letters from the Queensbury and Shelf District Councils urging them to carry out the extension of tramways to their respective places "at the very earliest opportunity."

Holland.—The *Financial Times* says that the Zuid-Hollandsche Elektrische Spoorweg Maatschappij is the title of a company formed for the purpose of constructing an electric railway to connect Rotterdam with the Hague and Scheveningen. The authorised capital is 3,000,000 florins of ordinary shares, and 4,000,000 florins of obligations, and of the latter 1,000,000 florins in 4½ per cents. are now being raised in Amsterdam and Rotterdam. It is estimated that the railway, which is promoted by Dutch and German capitalists, will be completed in 1903, at a cost of 7,800,000 florins, and it is due to this combination that the whole of the plant for the railway and all the electrical machinery have been ordered from Siemens & Halske, of Berlin.

Leeds.—The Council has resolved to apply for Parliamentary powers to construct several branch tramways to act as auxiliary lines to relieve the congestion in Boar Lane. It seems that "members of the Works Sub-committee are to be permitted to ride upon the platforms of the tramcars whenever they thought proper." It is stated that this will give them "the facility of instructing drivers and guards who are not properly doing their work." We hope these sub-committee members will be sure they themselves *know* what they propose to *teach*. We rather question whether this arrangement will lead to more efficient management of cars, rather would it lead to certain kinds of friction.

The Corporation is having an electric launch built for plying on the lake in Roundhay Park. The boat, which will accommodate 45 passengers, is to be launched on the Thames next week.

Liverpool.—At the last meeting of the Liverpool City Council a recommendation from the Tramways Committee that certain new lines of tramways, not included in last year's estimates, be constructed in the city of Liverpool at an estimated cost, with electrical equipment, of £23,167, was approved of after discussion. A further recommendation that Mr P. McCullough, works superintendent and general assistant, be appointed assistant manager of the Liverpool tramways at a salary of £500 per annum, was also agreed to. The Council authorised the Tramways Committee to order 100 new electric cars from Messrs. Dick, Kerr & Co., Limited, London, of the same type as those now being supplied under an existing contract, and at the price therein stated. By the end of the present year Liverpool will have 100 miles of electric tram route, probably all in operation. When the work of construction began it was expected that a mile of track per week would be constructed. The actual average has been two miles and a quarter per week, and two miles a week is now regarded by the city engineer, Mr. John A. Brodie, as an easily negotiable quantity. What may now be termed the standard type of Liverpool car is a double-decker, built on a single truck, and measuring 27 feet overall. The weight is 8 tons, and the car carries 56 passengers, and can be run on an expenditure of slightly less than 1 Board of Trade unit per mile. Each car is provided with two 25-H.P. motors. The Liverpool Corporation have now 220 cars in hand and 230 more on order. Three electrical generating stations have been established, the last two, those of Pumpfields and Lister Drive, having machinery of 12,000 H.P. each. Willans engines of 1,200 H.P. each are directly coupled to Siemens dynamos, and produce a current of 1,450 amperes at 550 volts. The electric cars, of 50 H.P., are run at a cost of 6·67d. per mile, against 10·14d. per mile under the old three-horse tram system.

Manchester and Liverpool Electric Railway.—Those responsible for the electric railway scheme are pushing the work forward with all possible speed, having decided to renew their application for Parliamentary sanction next session. Mr. F. B. Behr, the inventor, arrived in Liverpool on 5th inst., and the following day the local directors discussed the alterations in the plans. By certain modifications it is hoped to meet the objections of all concerned. The Dock Board were strong objectors on the last occasion, but their further action depends upon the amended Bill.

Midlands.—Trial trips have been made along the Kingswinford Electric Tramway during the last few days, and they point to the fact that the opening of the line for public use is near at hand.

The Light Railway Commissioners will hold their inquiry regarding the projected Kidderminster and Bewdley Electric Railway line on October 17th and not on September 17th, as has been previously announced.

Nelson.—The Town Council has decided to inform the Burnley Corporation that the Nelson Corporation would supply the electrical energy for trams within the borough of Nelson, buy its own rails, and carry out its own electric equipment.

Paris.—According to *Engineering*, a new electric line of the Orleans Railway Company in Paris, which is worked by electricity, and which is 2½ miles in length, runs from the Austerlitz depôt to the Quai d'Orsay, and is underground for its full length. An electrically-worked transfer platform, 30 feet long, connects all the tracks on the Quai d'Orsay. This platform can carry electric locomotives of 50 tons. The amount of power required for these locomotives is 500 KW., and the current is supplied through a third rail from three sliding contact shoes, while overhead wires are utilised at the Quai d'Orsay depôt, and also for the switches. The power station at Ivry contains two electric generators of 1,000 KW. each, producing a three-phase current of 5,500-volt pressure, and a frequency of 25 alternations per second. Two sub-stations transform this alternating current into a continuous current of 550 volts for power purposes, and of 500 volts for lighting.

Portsmouth.—The Tramway Committee of the Council have, after careful examination of tenders for plant for the new power station, recommended the acceptance of the tender of Messrs. Dick, Kerr & Co., for £29,656. They undertook to run one or two engine sets in six or seven months, and to complete the whole in nine months. For the building the committee recommended the acceptance of the tender of Mr. J. W. Perkins, for £10,515.

Spain.—The conversion of the tramways in the Eastern portion of Madrid to electric traction has just been completed.

£6,619. The total net profit since the commencement of the undertaking has been £20,586.

the Local Government Board to the borrowing of £11,950 for electric lighting purposes.

Wigan.—It is stated that the construction of the electric tramways is now proceeding rapidly, and in the course of a few weeks the station will be ready to supply current. The Wigan and District Tramways Company has intimated to the Council that it is prepared to consider a reasonable cash offer for their undertaking, or would lease any portion of the lines the Corporation had power to construct. After brief discussion the Tramways Committee decided to defer the question of purchase. The scheme for taking an electric tramway to two of the adjoining townships has received further consideration. There is opposition to the project on the part of the Stan dish District Council, the members of which do not think the roads wide enough, but if it is proposed to widen them they might probably discuss terms.

Windermere.—A meeting was held last week in opposition to the electric tramway proposed to be laid down between Bowness and Windermere and Ambleside. Mr. W. D. Hall, of Ghyll Head, Ambleside, occupied the chair. Among those present were the chairmen of the Ambleside and Bowness District Councils; Mr. David Ainsworth, ex-M.P., of Wray Castle; Canon Stock, of Windermere; Canon Rawnsley, of Keswick; and others, including artists from Bury, London, Manchester, Leicester, &c.

Mr. Gatey, secretary of the meeting, explaining the object of the gathering, stated that the scheme for laying the tramway would cost £54,000, and it was to be opposed, not only by the landowners and ratepayers of the district, but also by the Lancashire County Council. The County Council objected because the Electric Traction Company did not propose to widen the roads between Bowness and Windermere. On the plans there was only widening where the trams would pass each other. The chairman stated that the greater part of the road was only 20 feet wide, and if the County Council requirements were adopted the road would have to be widened to 30 feet, and its beauty would be ruined for ever. No one could suppose that visitors from distant parts came into the Lake District for a twopenny tram ride, and if they spoiled the aspect of the road they would drive the better class of visitors away. Then there would be the trolley poles and overhead wires. The scheme should be at once scotched, and they in that locality had a right to speak for the country. It was a national affair; they did not want the Lake District made into a town, and they must employ counsel to oppose the undertaking when the Light Railway Commissioners held their inquiry on the 24th inst.

Canon Rawnsley said Americans and foreigners who visited the Lakes spoke of the delight they experienced in leaving the trams behind in the large towns, and how they loved the quiet, beautiful scenery. They must oppose the scheme for the benefit of the workers. He did not think the tradesmen of Ambleside would benefit very much from such an undertaking. They grumbled at the present position of affairs, and rightly, because they had no cheap mode of travelling from Windermere to Ambleside. The coaches should be run to Ambleside at a cheaper rate. They might also bring pressure to bear on the London and North-Western Railway Company. He was asked by the National Trust to appear at that meeting, and they would see that counsel was instructed to appear on their behalf before the Commissioners.

Dr. Hall proposed "That this meeting offers its most strenuous opposition to the scheme."

Mr. Rawcliffe seconded the motion, which was carried unanimously, and a committee of gentlemen was appointed to take the necessary steps for engaging counsel.

Subscriptions to a substantial amount were made in aid of the expenses which will, necessarily, be incurred in opposing the projected tramways.

So far as this meeting is concerned, it is clear that (1) the County Council objects to the scheme, because the tramway company does not propose to widen the roads. (2) The chairman objects, because the roads would be spoilt by widening. (3) Canon Rawnsley objects on behalf of Americans and foreigners; also *for the benefit of the workers!*

Now, the first two objections cancel out; the third has absolutely no *locus standi*, and the remaining one is a gross error. To whom would cheap transit be of so much benefit as to the worker? Canon Rawnsley's speech contains its own refutation, for he admits that the tradesmen grumble, he advocates lower fares, and he even suggests an appeal to a *steam railway company*, of all things! We have heard that trolley lines are ugly; but who would venture to support a steam railway as a lesser evil?

Happily, such opposition as this is well-calculated to defeat its own object.

TELEGRAPH AND TELEPHONE NOTES.

Ashanti Telegraphs.—A dispatch from Coomassie says that the telegraph line between Coomassie and Cape Coast Castle was completed on 8th inst.

Berlin.—On July 26th, 1900, the *Electrotechnische Zeitschrift* published a description of the new exchange in Berlin known as "Office I," and a translation of this article appears in the *Telephone Magazine*, of Chicago, for August, together with an editorial criticism. The Berlin system is described as obsolete, and one which would not be tolerated in America, and it is interesting to note that the central battery system, which has been adopted by the British Post Office for London, is held up as the model system. The backward state of the Berlin system is attributed to the policy of the Government, which, it is stated, confines itself exclusively to home talent.

Grantham Telephones.—The Telephone Committee last week reported to the Council that as the result of an interview with Major-General Webber, they were favourably impressed that the establishment of a municipal telephone system could be successfully worked. At present they were not in a position to make any definite proposal, but hoped by the next meeting to be prepared to lay before the Council detailed estimates of the cost, &c., of the proposed undertaking, with a recommendation upon the subject. This report was adopted with four dissentients, and the common seal of the Council was attached to the Postmaster-General's license.

Imperial Telegraphs.—In his presidential address to the Geographical Section of the British Association, Sir George Robertson laid great stress on the necessity for shrinking the distances between the various parts composing the Empire. In the matter of telegraphs, according to the *Times* of the 7th inst., he strongly advocated the laying of submarine cables joining all the shores of the Queen's dominions and completely under British control.—"Important as are the sea-cables for statesmen, for strategy, and for commerce, they are or will be equally important socially to keep up intimacy and swift intercourse between families half in Britain and half in India for instance, or between friends and relations in these islands and in the great colonies. It is this interchange of personal news and private wishes, quite as much as the profound political and commercial aspects of lightning communication with all parts of the Empire, which will bind the Empire in bonds stronger than steel, easy as affection, to hold it together with unassailable power. Consequently the health and strength of the Empire depends very greatly upon a cheapening of telegraph charges. . . . . We must never forget the grand part in bringing together, within whispering distance as it were, the different parts of the world, and consequently of our world-wide Empire, which has been taken in the past by such Napoleonic organisers as the late Sir John Pender. It is to him and to such men as he that we owe those splendid beginnings which, by means of vital reflexes from the nerve centre of the Empire, have helped to fire our white fellow-subjects all over the globe with a loftier patriotism and with broader ideals of nationality."

Portsmouth Telephones.—At a Town Council meeting on Tuesday, Councillor Dittman proposed that the Finance Committee be instructed, as soon as 400 applications had been received, to apply to the Postmaster-General for a license empowering the Council to establish a municipal telephone exchange in Portsmouth. The Sub-Telephone Committee had sent out 8,000 circulars, inviting the inhabitants of Portsmouth and district to subscribe to such an exchange, and the number of replies received was encouraging. The Portsmouth Chamber of Commerce had passed a resolution in favour of the undertaking. After some discussion the resolution was adopted.

The Telegraph Wire Export Trade.—The telegraph wire export trade is of a spasmodic character, a fact which is well indicated by the returns for the past month. These show that the exports of telegraph wire and apparatus connected therewith from this country amounted during August last to the enormous total of £724,212, as compared with £205,306 in the preceding month, and only £87,517 in August, 1899. The activity which has so far this year ruled in this branch of trade, is shown by the fact that during the eight months ending with August last, the exports attained a value of £2,389,228, as compared with only £686,825 in the first eight months of 1899.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
South American:—		
Cayenne-Pinheiro	Oct. 11, 1899	
Pará-Maranham	March 1, 1900	
Ceará-Maranham	Feb. 20, 1900	
West Indies:—		
Mole St. Nicholas-Cape Haitien	March 6, 1900	
Latakia-Cyprus	June 20, 1899	
St. Louis (Senegal)-Bathurst	Aug. 25, 1900	
Tarifa-Tangier	Jan. 3, 1900	
Landlines:—		
Chinese:—		
Tientsin-Pekin	June 12, 1900	
Pekin-Kalgan	June 14, 1900	
Kalgan-Maimatchin	June 30, 1900	
Tientsin, *via* Shanghai	June 16, 1900	
Tientsin-Niuchwang	June 18, 1900	
Saigon-Bangkok	Sept. 7, 1900	Sept. 7, 1900
South American:—		
Communications with all offices of Columbia beyond Buenaventura	January 29, 1900.	
Ecuador landlines	March 13, 1897	
Landlines south of Macahé (Brazil)	April 20, 1900	
Landlines south of Serena	July 30, 1900	
Communication "*via* Hanekine" interrupted on Persian territory	Feb. 24, 1900	
Siberian—		
Irkoutsk-Werkhne-Oudinsk	Sept. 8, 1900	Sept. 8, 1900
" " "	Sept. 12, 1900	

Telegraphists at the Trade Union Congress.—The telegraphists, in common with the sorters and postmen, have been represented this year at the Trades Union Congress at Huddersfield. Last week, Mr. Garland (London Postal Telegraph Clerks' Association) moved a resolution urging upon the Postmaster-General the necessity for a thorough investigation of the causes of mortality and sickness among telegraph clerks, and the publication of the full details of such investigation. The motion further declared that the practice of compulsory and excessive overtime in the Post Office is injurious and unjustifiable; that the system of fines for misconduct is extremely harsh; that the Factory Acts should be so amended as

per cents. are now being raised in Amsterdam and Rotterdam. It is estimated that the railway, which is promoted by Dutch and

Spain.—The conversion of the tramways in the Tasconi portion of Madrid to electric traction has just been completed.

to include all Government buildings, and that these, together with all other causes of discontent among postal and telegraph workers, should be inquired into by a Select Committee.

Mr. Cheeseman (London Fawcett Association), seconded the motion, which was supported by Mr. Churchfield (London Postmen's Federation), and adopted.

Mr. Hall (Liverpool Postal Telegraph Clerks) moved that the same rights of combination as are enjoyed by other trade unionists should be granted to Post Office employés.

Mr. M'Laren (Glasgow Postmen's Federation) seconded the motion, which was supported by Mr. Clery (Fawcett Association) and Mr. Steadman, M.P., and agreed to.

On Saturday last a crowded meeting of postal and telegraph workers was held in Northumberland Street Schoolroom, Huddersfield, under the auspices of the Joint Federation of Postal and Telegraph Associations (Huddersfield branch). The chair was taken by Sir James T. Woodhouse, Kt., M.P., who was supported by Mr. W. C. Steadman, M.P. The speakers were Messrs. C. H. Garland (London), C. E. Hall (Liverpool), W. E. Clery (London), W. B. Cheesman (London), A. Maclaren (Glasgow), C. Churchfield (London), and J. H. Priestley (Huddersfield). The following resolutions were passed unanimously amid much enthusiasm:—

That this representative assembly of postal and telegraph employés diligently support every constitutional method of securing the removal of departmental regulations curtailing our civil rights, and that we further declare our intention to use every legitimate means of obtaining a re-hearing of our grievances by an independent and impartial committee of inquiry, whose findings we pledge ourselves to loyally accept.

This joint meeting of the Postal and Telegraph Associations hereby expresses its disappointment at the unsatisfactory reply of Mr. Hanbury, under date of June 22nd, to the memorial forwarded to the First Lord of the Treasury and signed by a majority of members of the House of Commons, and reiterates its determination to support the deferred pay movement until a satisfactory settlement has been obtained.

That this mass meeting of Postal and Telegraph employés hereby records its appreciation of the services of those M.P.'s who have so consistently supported our legitimate claims for consideration during the last Session of Parliament, with which we especially desire to couple the name of the hon. member for Stepney (Mr. W. C. Steadman).

Tunbridge Wells Telephones.—At a meeting of the Town Council on 5th inst., tenders were accepted for the installation of a telephone service. The scheme also provides for a service to the surrounding villages. It is estimated that the initial cost of the installation will be £9,000, and the annual cost of working about £1,000.

Underground Wires.—At the recent meeting of the Association of Chambers of Commerce in Paris, according to the *Standard*, a motion by Mr. Hayward, of Dover, in favour of connecting lightships and isolated lighthouses with the shore by means of wireless telegraphy was unanimously passed, as was also a proposition of Mr. Hemrych, of Liverpool, having reference to the desirability of increased efficiency and economy in the telegraphic communication between the different parts of the Empire. Mr. Plummer, of Liverpool, moved:—"That the Executive Council be requested to urge upon Her Majesty's Postmaster-General the great importance of the necessity that exists for connecting, by underground wires, the chief commercial towns and seaports, so that the very serious losses arising through the interruption of the present system by gales of wind and snowstorms may be avoided in future." He said it frequently happened after a severe gale in the Midlands that the North of England was cut off from the South, owing to the breakdown of the overhead wires. These stoppages sometimes lasted five days, and the loss to trade was enormous. To reach Cardiff, he had been forced to send a message to Glasgow, from where it was transmitted to the North of Ireland; it next journeyed to Dublin, and finally reached Cardiff by the Southern cable. On other occasions, to reach London they had to send messages to Northumberland, where the Danish cable landed. Having been sent to Denmark, the telegrams were re-transmitted to mid-Europe and then across the Channel to London. The Treasury and the expense, he was aware, blocked the way, but commercial necessities demanded the underground wires. Mr. Cooper, of Dundee, who said that in winter they were sometimes cut off from communication with the world for four days, seconded the resolution, which was adopted.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—September 29th. The Electric Lighting Committee wants tenders for two 200-kw. direct coupled continuous current generators, and one 120-kw. balancing set; one 420-kw. direct coupled generating set. All Willans engines. See "Official Notices" August 24th.

Brighton.—October 1st. The Corporation invites tenders for electric motor cars, steel rails, fishplates, &c. See "Official Notices" September 14th.

Brussels.—September 19th. The Council of St. Jilles, lez Bruxelles, invites tenders for the installation and the commencement of supply upon a part of its territory. Conditions and plan for three francs at the office, No. 14, Parvis St. Jilles, St. Jilles.

Budapest.—October 15th. The Hungarian Minister of Commerce is prepared to receive tenders for the installation of two telephone exchanges, local and interurban, complete in all respects. See "Official Notices" August 3rd.

Copenhagen.—September 19th. Tenders are wanted for two steam boilers for the electricity works. See "Official Notices" August 31st.

Dublin.—October 4th. The Electric Lighting Committee wants tenders for the supply and laying of mains and accessories. See "Official Notices" August 31st.

Dundalk. — September 18th. The Urban District Council invite proposals for a transfer of their electric lighting order for the purpose of supplying electricity for public and private lighting and energy for manufacturing purposes within the urban district of Dundalk. Full particulars at the office of the Borough Surveyor, Town Hall, Dundalk.

Eastbourne.—October 4th. The Corporation wants tenders for a water-tube boiler and fittings, 400-kw. steam alternator and switchboard. See "Official Notices" September 7th.

Fulham.—September 25th. The Vestry invites tenders for plant for unloading and storing coal at the electricity works. See "Official Notices" to-day.

Glasgow.—September 28th. The Corporation are prepared to receive tenders for the supply and fitting up of the power station piping required at Pinkston. Specifications, &c., on application to Mr. John Young, general manager, 88, Renfield Street, Glasgow. A bank draft for five guineas, payable to the General Manager, must accompany each application for specifications.

Hackney.—October 3rd. The Electric Lighting Committee wants tenders for electricity supply mains. See "Official Notices" this week.

Hampstead. — September 27th. The Vestry invites tenders for eight marine boilers, piping, feed-heater or detartariser, fuel economiser, and tanks. See "Official Notices" August 24th.

Hull.—September 27th. The Corporation wants tenders for certain steam and water pipes, pump, water softener, &c., for electricity works. See "Official Notes" August 24th.

London.—September 24th. The L.C.C. is inviting tenders for the supply of mains for the installation for the Victoria Embankment and Westminster Bridge. See "Official Notices" August 31st.

London County Council.—September 22nd. Tenders are wanted for boilers, engines, dynamos, &c., at the Horton Estate Epsom, Surrey. See "Official Notices" August 10th.

Luton.—September 14th. The Town Council invites tenders for watt-hour and demand meters. See "Official Notices" August 3rd.

Manchester.—September 18th. The Tramways Committee wants tenders for two steel boilers for heating, cast-iron pipes, rubber rings, bolts and nuts, steel stanchions, and 100 car trucks. See "Official Notices" September 7th.

Mexborough.—September 15th. The Council wants tenders for a Lancashire boiler, two 50-kw. dynamos, balancer and boosters, feed heater, and pump, switchboard, battery, mains, crane, and adapting the street gas lamps for electric lighting. See "Official Notices" August 31st.

Nelson.—September 18th. The Gas and Electricity Committee wants tenders for the supply of electric light cable. See "Official Notices" September 7th.

Perth. — September 15th. The Commissioners want tenders for direct current meters and cut-outs. See "Official Notices" August 31st.

Plumstead.—September 19th. The Vestry wants tenders for boilers, refuse destructor, steam fittings, economiser; steam piping, pumps, &c., &c.; steam generators—two 300-i.h.p.; two 150-i.h.p.; and one 100-i.h.p.; condensing plant, cooling tower, &c.; switchboard; battery; traveller; mains, meters, arc lamps and posts, &c. See "Official Notices" August 10th.

Salford.—October 2nd. The Cleansing Committee of the Corporation wants tenders for a two or three-cell refuse destructor. Also for a six-cell destructor on the forced or accelerated draught principle, together with necessary boilers, &c. See two "Official Notices" August 31st.

Sheffield.—October 6th. The Corporation wants tenders for two two-phase steam alternators and exciters of 600 kw. each, and the alteration of present single-phase plant to two-phase plant. See "Official Notices" to-day.

Suffolk.—October 5th. The Visiting Committee of the County Lunatic Asylum wants tenders for the wiring and fitting of the County Asylum at Melton for electric lighting. See "Official Notices" this week.

Sunderland.—September 21st. The Corporation wants tenders for triple expansion high speed, direct current dynamos, Lancashire boilers, feed pumps. See "Official Notices" August 31st.

Walthamstow. — September 25th. The Council is inviting tenders for gas plant, gas engines, dynamos, switchboards, boosters, balancer, and measuring instruments. See "Official Notices" August 31st.

Whitehaven.—October 13th. Tenders are wanted for the supply and erection of a switchboard at their electric lighting station. See "Official Notices" this week.

Wrexham.—Tenders are wanted for a dynamo and three electric motors, &c., to drive centrifugal pumps. See our advertisement pages August 31st.

CLOSED.

Bradford Workhouse.—The Board of Guardians has decided to accept the tenders of the following firms:—For No. 1 Section, C. A. Parsons & Co., £900; No. 3 Section, Electrical Power Storage Company, £1,025; No. 4 Section, G. A. Steinthal, £308; No. 5 Section, G. F. Cook & Co., £613; for steam separator and steam trap, C. A. Parsons & Co., £20.

Cardiff.—The Lighting Committee has accepted the tender of the British Insulated Wire Company for high tension cables at £607.

London.—At Tuesday's meeting of the City of London Union the tenders were opened for the installation of electric lighting at the board's offices in Bartholomew Close, E.C. Four firms were invited to tender, with the following result:—

J. O. Grant	£542 7 0
Newsome, Pinching & Walton	430 0 0
William Heath	624 0 0
Edward H. Leaf	545 10 0

The tender of Messrs. Newsome, Pinching & Walton was accepted.

Nuneaton.—The contract for the supply of storage battery, required by the Nuneaton and Chilvers Coton Urban District Council for their electric lighting extension, has been placed in the hands of the Hart Accumulator Company, Limited.

Roumania.—The Roumanian Post and Telegraph authorities in Buda-Pesth recently invited tenders for the supply of 40 tons of galvanised steel wire 2 mm. diameter. Messrs. Richard Johnson, of Manchester, succeeded in submitting the lowest offer, quoting 699·8 francs per metrical ton.

NOTES.

Steam Engine Records.—Prof. Ripper advocates continuous recording of steam engine performance by means of his new indicator. He advocates more frequent and systematic examination of daily working conditions, and thinks these results should be visible and recorded. This, of course, can easily be done by his throttling indicator or steam gauge with an autographic record similar to the Bristol pressure recording gauge. He instances the application of his mean pressure indicator to the engines of the new ship *Saxonia*, which has two sets of quadruple expansion engines, and had one instrument fitted to each cylinder of one set. The results, compared with ordinary indicator diagrams taken throughout the trial are almost identical, showing a mean effective pressure of 40 lbs. referred to the L.P. cylinder. The Professor has devised a board of scales and pointers on which at any time the mount of a pointer to the figure recorded by the instrument for each cylinder points to the equivalent pressure referred to the L.P. cylinder, and the figures are added up easily to the L.P. equivalent. He also furnishes other rules for ascertaining steam consumption on varying loads as well as pointing out the conditions under which his instrument fails in accuracy. Locomotives and non-condensing compound engines present most difficulty, owing to high compression. What is wanted, however, is some instrument that will continuously measure the discharge from a surface condenser. It is not absolutely necessary that it should measure it positively so much as relatively, so as to produce a curve on a moving ribbon that could be laid parallel with, say, the record from the ammeter. Some such record as this is most desirable to show the influence from time to time of the variation of load on a power station. The effects of overload and of underloads would be apparent, and the economical load would be quickly ascertained, and might lead to great modification in engine design. Possibly some gauge could be contrived on the principle of measuring the velocity of outflow of a jet of water from a pipe, the height in which would be maintained in accordance with the amount of water flowing to it from a surface condenser; the outflow velocity being measured by a Venturi meter. For an electric plant the engine power is not so very important. It is desirable to know its water consumption unloaded and at all states of load, but once the overall plant efficiency is known, the output in amperes is quite sufficient for purposes of comparison with the water consumption.

Electric Trams and Suburban Industries.—In the recently-issued annual report of the chief inspector of factories (says the *Hospital*) there is a bit of information in regard to the effect of the tramway system in lessening centralisation, and consequent overcrowding of both population and industries, which is of much importance. People are apt to regard the introduction of tramways, so far as it touches the question of overcrowding, merely as a means of enabling the city workers to live in the purer air of the suburbs far away from their work. We, however, have always maintained that if once cheap and rapid inter-communication were established, not only would the people be drawn to the outer ring, but that many of the industries would go there also, taking advantage of the cheaper labour to be found in the suburban districts. This is just what seems to be happening in Bristol. The factory inspector of that city says that, owing to the enterprise of the tramway company in extending their electric system of lines into the suburbs, a revolution is being rapidly effected in the domestic life of the workpeople. Several firms, such as manufacturers of tobacco, clothing, corsets, ropes, &c., have already built fine modern factories on the outskirts of the town, and round these factories have sprung up rows of neat cottages, in some cases built and owned by the factory proprietors, who rent them to the workpeople. Here the people live in pure air instead of being cooped up in the narrow streets of the city, and yet, thanks to the tramways, they still have the advantages of city life, so far as regards shops, &c. Workers in the city also have the advantage of being able to sleep in the suburbs. Altogether, says Mr. Maitland, the inspector, few modern inventions have conferred greater benefits on the workpeople than have electric tramways, and if throughout the country, and especially in and around large cities, electric tramways receive the encouragement they deserve they may become an important factor in the solution of the overcrowding problem. These are our sentiments exactly. We do not limit, as some would, the benefits of the tramways to the mere facilities they would offer to the city worker in the way of having his home in the suburbs. The far greater benefit which will result from the extension of the tramways will be that the towns themselves will spread out. With the increased facilities of intercommunication between one part and another, the tendency of the industries as well as of the people to crowd into the centre will be greatly lessened. It is nonsense to hold that health can only be maintained in the country. If towns were opened out enough they might still be healthy, even though they might be what are called "manufacturing towns" from end to end.

Calcium Carbide.—The *Financial Times* says that the report of the Chamber of Commerce for Lorrach and Waldshut states that in consequence of the recent establishment of numerous works for the manufacture of carbide of calcium for acetylene gas lighting purposes, the production of the material now meets the demand in Germany. It is estimated that the output of calcium carbide on the European Continent alone will amount to 100,000 tons per annum during the next few years.

Personal.—Mr. W. H. Eccles and Mr. C. F. Smith have been respectively appointed to the posts of senior demonstrator of physics and senior demonstrator of electrical engineering at the South-Western Polytechnic, Chelsea.

On Monday last the employés of the Watford Electricity Works presented Mr. H. Turnbull with a gold mounted malacca walking stick, as a mark of respect before his leaving this country for America.

Mr. Arthur B. Child, A.I.E.E., has been appointed engineer and manager to the Galway Electric Company, Limited, in succession to Mr. Leopold Heath, A.M.I.E.E., who has joined the staff of the British Thomson-Houston Company.

Mr. J. H. Cawthra, chief assistant electrical engineer in the lighting department of the Leeds Corporation, has been appointed borough electrical engineer to the Corporation of Swansea, at a salary of £300 per annum. Mr. Cawthra, Mr. P. J. Pringle, resident electrical engineer at the Brush station at Wandsworth, and Mr. S. G. Britton, of Barking, were the selected three out of 76 applicants.

of Commerce is prepared to receive tenders for the installation of two telephone exchanges, local and interurban, complete in all respects. See "Official Notices" August 3rd.

the supply and erection of a switchboard at their electric lighting station. See "Official Notices" this week.

Night Lights in the Navy.—The sights which are used for the quick-firing guns in the Navy at night time consist of tiny little electric lamps which throw a beam of light on to a small reflector on the actual sight itself. The sights are distinguished by means of their colour. Thus the near sight is covered with a small screen of red glass. The current is maintained by means of a three-cell agglomerate block Leclanché battery with a switch of varying resistance. When properly manipulated the light is supposed to continue for two hours, but as the switch is controlled by the captain of the gun, great supervision is necessary to keep him from switching off all the resistance at once and running the battery down too soon. Were the resistance to vary automatically, instead of being at the mercy of the captain of the gun, who, by the way, is not necessarily an electrician, there would probably be far more satisfaction got out of the battery.

International Association of Municipal Electricians of America.—The secretary informs us that the fifth annual meeting of the above Association, to be held on the 25th—27th inst., is to be "the most profitable and interesting assemblage" in the history of the Association. It will be held at Pittsburg, and Mr. M. W. Mead, chairman of the Executive Committee, and superintendent of the Pittsburg Bureau of Electricity, is straining every effort to make the convention a success. With thoughtful care the free use of the telephone and telegraph services, special railroad terms, and special accommodation at the leading hotels, have been arranged for on behalf of the delegates, and a Ladies' Reception Committee has been formed to ensure the comfort and entertainment of their fair relatives; trips by trolley car and steamboat have also been organised in advance. Evidently the municipals are going to have a real good time!

British Institution of Draughtsmen.—On the 7th inst. the members of the Manchester branch visited Blackpool for the purpose of viewing the electric light station and the generating station of the Blackpool and Fleetwood Tramroad Company. The former was especially interesting owing to the various types of generators employed. It was noticed that extensive alterations are in progress, including what promises to be an unusually large chimney stack. The members were much indebted to Mr. Robt. C. Quin, the electrical engineer, for his kindness. The generating station of the Blackpool and Fleetwood Tramroad Company was also interesting. The visitors were received by Mr. McMahon, who kindly explained the points of interest. The plant consists of five combined sets of 150 KW. each, by Mather & Platt, and has run since its installation without any mishap.

Application of Electricity to Tree Felling.—It became advisable to cut down a large elm tree at the Illinois Central Hospital, and as the cross-cut saw provided was not long enough, someone suggested to the electrician of the place to "electrocute" the tree. Subsequently the engineer becoming interested, provided a small dynamo for regulating the voltage, and by taking current from the supply mains through a 20-foot length of No. 16 iron wire, raised it to a bright cherry heat. The wire was given a slow to and fro motion, to admit air enough to burn the wood after the moisture had been evaporated, and the tree was felled in 2 hours and 10 minutes. Current, 120 to 135 amperes; voltage, 80 to 115.

Fatal Accidents.—The body of H. Halliwell, recently appointed sub-engineer of telegraphs at Dublin post office, was found in the Liffey last week, the deceased having apparently fallen into the water.

A passenger by the Waterloo and City Railway, Geo. C. Lucas, slipped off the platform at Waterloo and fell in front of one of the trains, which passed over him. Terrible injuries were received, rendering amputation necessary, and death took place 48 hours after the accident.

Prof. Tyndall's Electrical Apparatus.—On September 22nd several lots of electrical appliances, formerly the property of the late Prof. Tyndall, are to be offered for sale by auction at Andover, Hants. Some particulars are given in an "Official Notice" this week.

General Election Notes.—Mr. Emile Garcke was spoken of as the probable Liberal candidate for Swansea borough at the next election, but he has contradicted the report.

Sir James Pender will be opposed by the Rt. Hon. C. R. Spencer, who will be the Liberal candidate in Mid-Northamptonshire.

"The Engineering Times."—The August issue of this journal (5s.), which is devoted exclusively to the Paris Exhibition and its engineering exhibits, has gone into a second edition. Separate articles which, on the whole, are well illustrated, deal with such classes as railway plant, steam engines, wood-working machinery, oil engines, gas engines, electrical machinery, agricultural machinery, and so forth. Among the signed articles is one by Mr. Ernest D. Phillips on the Westinghouse electrical plant. The electrical machinery exhibits are only given eight pages. Altogether we should think the number would be useful to those who are interested in the Paris machinery exhibits.

Electric Railways in London.—The New York correspondent of the *Daily Telegraph* says:—

According to Mr. Bernard M. Baruch, of the A. A. Housman Company, Mr. Charles T. Yerkes has purchased the franchise and all the rights of the Charing Cross, Euston, and Hampstead Railroad, and has formed a syndicate of American capitalists to build a tunnel railroad under the streets from Charing Cross to Hampstead Heath; also an extension of two miles from Camden Road to Kentish Town. Mr. Yerkes's agents reported that the road, if built, promised good returns. Mr. Yerkes, on receiving the assurance that several friends in New York and Chicago would help him to finance the scheme, went to London and bought the company's rights. Mr. Baruch said that the $12,000,000 needed to build the road would all be American capital. The road will probably have 10 stations and four tracks, two for express and two for local trains. Electricity will be the motive power. It is estimated that connecting railroads will bring the Charing Cross-Hampstead line within the reach of 150,000 persons.

Appointments Vacant.—A shift engineer is wanted for the Rathmines Electricity Works; also one is required for the Halifax lighting and tramway station. See "Official Notices."

Marriages.—On September 12th, at St. Thomas' Church, Coventry, the marriage was solemnised of Mr. Joseph Edward Dodds and Miss Ethel King, daughter of Mr. William Baldock, of Coventry. Mr. Dodds has supervised the laying of many thousands of miles of electric light and traction cables for the British Insulated Wire Company, Prescot.

On Thursday last week, at Plymouth, Mr. E. G. Okell, assistant borough electrical engineer, Plymouth, to Miss E. M. Coleby.

Cricket.—A match was played at South Tottenham on Wednesday last between the Engineer-in-Chief's Office and Controller of Stores' Office, G.P.O. The latter won on the first innings by 21 runs. Scores:—Engineer-in-Chief's Office, 29 and 45 for two wickets; Controller of Stores' Office, 50, of which Crisp contributed 23.

Obituary.—The *Melbourne Age* for August 6th announces the death at Sydney of Mr. P. B. Walker, secretary and engineer-in-chief of the electric telegraph department, at the age of 60 years.

NEW COMPANIES REGISTERED.

Sherard Cowper-Coles & Co., Limited (67,136).—This company was registered on September 4th, with a capital of £25,000 in £1 shares, to acquire the business now carried on by S. Cowper-Coles at Grosvenor Mansions, Victoria Street, and Wallis's Yard, Westminster, S.W., and to carry on the business of mechanical, consulting and electrical engineers, electricians, metallurgists, producers and suppliers of electric light and power, ironfounders, smiths, tool makers, machinists, chemical manufacturers, chemists, &c. The first subscribers (each with one share) are:—H. R. Braid, 21, Esmond Road, Bedford Park, W., electrical engineer; E. G. Woodridge, 37, Upper George Street, Bryanston Square, W., clerk; H. Sayer, 29, St. George's Square, S.W., metallurgical engineer; H. Groome, 42, Grange Road, Ealing, electrical engineer; M. A. Hankey, 105, Marina, St. Leonards-on-Sea, electro-metallurgist; F. S. Spiers, 20, Christopher Street, Finsbury Square, E.C., electro-chemist; and C. E. Peczenik, 53, Portland Place, W., engineer. The number of directors is not to be less than three nor more than five. The first are the Marquis of Queensbury (chairman), W. B. Cowper-Coles (deputy chairman), J. Day, R. Steele and Samuel H. Cowper-Coles; remuneration, £300 per annum, divisible.

quite sufficient for purposes of comparison with the water consumption.

station at Wandsworth, and Mr. S. G. Britton, of Barking, were the selected three out of 76 applicants.

Electric Incandescent Lamp Regenerating Syndicate, Limited (67,160)—This company was registered on September 8th, with a capital of £7,500 in £1 shares, to carry on the business of electrical engineers, manufacturers and contractors, and in particular to acquire and turn to account certain letters patent, granted and to be granted, on the terms of an agreement between E. Cadett and W. H. Thompson, of the one part, and G. Hollingum, as trustee for the company, of the other part. The first subscribers (each with one share) are:—M. J. Cannon, 101, The Chase, Clapham Common, S.W., chemist; W. Thompson, 8, Dalebury Road, Upper Tooting, S.W., clerk; A. F. Edwards, 40, Lexham Gardens, S.W., gentleman; E. P. Richmore, Hampton Wick, gentleman; H. Flint, 9, Canterbury Road, Brixton, S.W., clerk; J. F. Aydall, Kelmscott House, Hammersmith, W., gentleman; and R. Kelley, 34, Woburn Place, Russell Square, W.C., clerk. The number of directors is not to be less than three nor more than seven; the first are to be appointed by the subscribers.

Stock Exchange Notices.—Application has been made to the Committee to appoint a special settling day in and to grant a quotation to Eastern Extension, Australasia, and China Telegraph Company, Limited—Further issue of 50,000 shares of £10 each. The Committee has further been asked to allow the following to be quoted in the Official List:—Western Telegraph Company, Limited —4 per cent. debenture stock.

W. T. Henley's Telegraph Works Company, Limited. The first batch of letters of allotment and regret for the recent issue of W. T. Henley's Telegraph Works Company, Limited, ordinary and preference shares, have been posted. Both classes of shares were largely over subscribed for.

W. T. Glover & Co., Limited.—Notice is given that the preference share transfer books will be closed from the 17th inst. to the 29th inst., both inclusive, for the preparation of dividend warrants.

Telegraph Manufacturing Company.—The transfer books will be closed as regards the preference shares from 15th to 29th inst., inclusive.

Commercial Cable Company.—The transfer books will be closed on 20th inst. until 2nd prox.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending September 8th, 1900, were £1,395 6s. 7d.; receipts for corresponding period, 1899, £1,33[illegible] 17s. 2d.; aggregate for half-year to date, £14,520 9s. 10d.; aggregate corresponding period of last half-year, £14,798 2s. 7d.

The Bristol Tramways and Carriage Company.—The receipts for the week ending September 7th, 1900, were £3,629 4s. 10d.; corresponding period, 1899, £3,697 12s. 3d.; decrease, £68 7s. 5d.

The Central London Railway.—The receipts for the week ending September 8th, 1900, were £4,647; previous week, £4,499; increase, £148. Total receipts to September 8th, 1900 (6 weeks), £27,475. Miles open, 6.

The City and South London Railway Company.—The receipts for the week ending September 9th, 1900, £1,487; September 10th, 1899, £886; increase, £601. Total receipts for half-year, 1900, to date, £15,023; corresponding period, 1899, £9,439; increase, £5,584. Miles open, 1900, 4½; 1899, 3¾.

The Cork Electric Tramways and Lighting Company.—The receipts for the week ending Thursday, September 6th, 1900, were £547 9s. 2d.; corresponding week last year, £498 9s. 8d.; increase, £48 19s. 11d. Total to September 6th, 1900, £14,742 18s. 7d.; corresponding period last year, £13,520 6s. 5d.; increase, £1,222 12s. 2d.

The Dover Corporation Tramways.—The receipts for the week ending September 8th, 1900, were £292 17s. 3d.; September 9th, 1899, £293 18s. 4d.; decrease, 16s. 1d. Total receipts to date, 1900, £7,416 9s. 4d.; corresponding period, 1899, £7,074 19s. 0d.; increase, £341 10s. 4d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 5,152; 1899, 4,916. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, September 7th, 1900, were as follows:—D. U. T. Co., horse cars, £33 14s. 0d.; ditto, electric cars, £4,063 1s. 6d.; D. S. D. Co., electric cars, £1,133 11s. 3d.; total, £5,230 7s. 2d; corresponding week last year—D. U. T. Co., horse cars, £1,198 6s. 11d.; ditto, electric cars, £2,311 6s. 3d.; D. S. D. Co., electric cars, £1,050 13s. 9d.; total, £4,560 6s. 11d.; increase, £670 0s. 3d.; aggregate to date, £50,985 15s. 4d.; aggregate to date last year, £46,808 8s. 9d.; increase to date, £4,177 6s. 7d. The mileage worked is 43 miles electrically, 1 mile by horses, as against 24 miles electrically, 20 miles by horses, for the corresponding period last year.

The Halifax Corporation Tramways.—The receipts for the week ending September 9th, 1900, were £919; corresponding period, 1899, £750; increase, £169. Total receipts to date, 1900, £18,467; corresponding period, 1899, £14,352, increase, £4,115. Miles of track open, 1900, 16½; 1899, 9. Number of cars, 1900, 29; 1899, 21.

The Liverpool Overhead Railway Company.—The receipts for the week ending September 9th, 1900, were £1,792; corresponding week last year, £1,614; increase, £178. Total traffics from July 1st, 1900, £17,487; ditto corresponding period, 1899, £17,269; increase, £218. Miles open, 6·57 chains.

STOCKS AND SHARES.

Wednesday Evening.

Once again have Stock Exchange markets recovered their wonted optimism. After so many weeks of languid business, the sudden accession of orders to the mining departments this week produced a better feeling in every department, with the result that prices have been marked up all round, the electrical sections proving no exceptions to the general rule. Only in two cases have we to chronicle a decline this week, whereas rises are fairly plentiful. It can also be taken for granted that quotations, in many instances where no change is officially recorded, are really harder, and that the middle prices of a large proportion of stocks and shares alike can now be obtained by those desirous of selling.

A strong impression is gaining ground in Stock Exchange circles that the markets are on the eve of much better business, which will naturally bring about a further advance in values. The prophesy has been so frequently falsified when made in the past that it is difficult to quite believe in it this time, but perhaps conditions at the present time are more in favour of an increase in business than they have been for some months.

The feature of the electrical supply market is a new issue of shares that the Metropolitan Company is making. Shareholders are offered, *pro rata*, 150,000 shares at par, *i.e.*, £10, the last day for applying being October 1st. The market is quoting these new shares at 2 to 2½ premium, at which they are cheap as compared with the existing issue. Considerable discussion is going on as to when the new will rank on all fours with the old. The former will be fully paid in May next, and the assumption is that all shares will be on equal terms after the company pays its interim dividend next June. This, however, is challenged in some quarters, and expert opinion in the market is still divided on this point, which, of course, makes a good deal of difference in appraising the correct value of the new shares.

After a long period of inanition, London Electric Supply shares of both classes are well to the fore again. The Ordinary are up ¼, and the Preference ½ since this time last week. It is stated that the company is full of orders and doing exceedingly well. Perhaps the recent change that has been made in the *personnel* connected with the London Electric is also not without its significance. The shares have come into strong demand, and the Preference—upon which the last dividend was not paid—are regarded as a favourable speculation. Smithfield Electrics found a buyer at £2 on Tuesday.

On more than one occasion of late we have referred to the unostentatious buying of good class electrical and telegraph debentures, and the purchasers are still at work. City of London 5 per cents. are the latest to move, having been marked up a point. Eastern Telegraph Debenture stock is 2 to the good on the week, and Eastern Extension Debenture has also risen 2 per cent.

The American Telegraph Companies must undoubtedly be feeling the competition of the new German line very shortly, and the Stock Exchange has anticipated sellers by putting down Anglo "A" to 12, a fall of ½ per cent. This is only in accordance with the course we lately pointed out as likely to be taken. Direct United States Cable shares are also weak, but the pre-Ordinary issues of both concerns are unchanged. Commercial Cable stock maintains its price, and the company may possibly benefit by the advent of the German competitor, the two boards having, we understand, arrived at an agreement between themselves. As regards other telegraph descriptions, Eastern Ordinary has advanced sharply on purchases for account of investors, and the 3½ per cent. Preference stock has risen to a shade over par. "Chinas" show an officially recorded rise of 5s., although there are buyers at better quotations than would appear from the list price.

There is a noticeable disposition towards revival in the prices of the West Indian Telegraph securities, which have been dormant for some time past. West India and Panama issues are wanted. On another Continent some attention is being directed to the West African Telegraph Company, the 5 per cent. Debentures of which are quoted at 98½. The recent Ashanti expedition has swollen the company's receipts, which have also been assisted by the war in the Transvaal. Under these circumstances, the Debentures do not look dear, although the price has been put up 1 per cent. since last week.

Henley's fail to wholly pick up the loss that they registered upon the issue of new capital, but they are 10s. better on the week. The latest shares—of which we urged allottees to buy more a week ago at the then price of ⅞ prem.—are now 1⅛ prem., and we do not consider them worth selling yet. Callender's Ordinary are a better market than they look, but the Preference are 5s. down. Edison and Swan Second Debenture stock, £70 paid, is quoted at 68 to 72. Dealings in it are of limited proportions.

The railway and traction markets are very quiet. Central London divided shares command £5, and the old are saleable at 10⅛. City and South London stock is unchanged. British Electric Tractions are steady. Anglo-Argentine Trams slipped back to 3⅞, but recovered to 4. Buenos Ayres and Belgrano "A" shares are 5. Middle Calcutta Tramway shares are harder, and this market is, speaking generally, a good one.

in an "Official Notice" this week.

Cowper-Coles (deputy chairman), J. Day, R. Steele and Lieutenant H. Cowper-Coles; remuneration, £300 per annum, divisible.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation September 5th.	Closing Quotation September 12th *	Business done during week ended September 12th, 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
125,000	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s.	73/6	58 — 61	58 — 61	...	...
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	110½—111½	110½ 111½	111½	110½
3,062,240	Do. do. Deferred	Stock	...	18s. %	£1 7s.	12¼— 12¾	11¾— 12¼	12¼	11 11/16
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	4 %	2½— 3½	2½— 3½	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	...	165 —175	165 —175	...	...
1,563,078£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	101 —103	103	102¼
16,000	Cuba Telegraph	10	7 %	8 %	7 %	6½— 7½	6½— 7½	7½	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	15 — 16	15 — 16	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	...	4 — 5	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104%	100 —104 %	...	...
60,710£	Direct United States Cable	20	3¼%	3½%	3 %	11 — 11½	10¾— 11¼	11	...
111,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	146 —151	149 —154	150½	148
1,795,000	Do. 3½ % Pref. Stock	100	...	...	...	97 —100	99 —102	100½	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	112 —117	114 —119	115¾	114¼
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	14¾— 15¼	15 — 15¼	14⅞	...
6,700£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	... — ...	... — ...	...	...
26,600£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	... — ...	... — ...	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	111 —116	113 —118	115	114
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103%	100 —103%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5½%	5¼%	11 — 11½	11 —11½	11 1/16	...
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	14¾— 15¼	14¾— 15¼	15⅛	15
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	12½%	...	32 — 34	32 — 34	...	...
84,300	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	98 —101	98 —101	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	51 — 55	51 — 55	52⅞	52
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	103 —106 xd	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	⅝— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	4⅜— 4⅞	4⅝— 4⅞	4 13/16	4¾
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	14¼	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5 — 5¼	5 — 5¼	5 3/16	5 1/16
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	98 —101	98 —101	99¼	98½
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7½— 8½	7½— 8½	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	125 —130	125 —130	...	...
58,000	United River Plate Telephone	5	5 %	6 %	7 %	4¾— 5¼	4¾— 5¼	...	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000£	West African Telegraph, 5 % Debs....	100	...	...	...	96 — 99 xd	97 —100	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	99 —102	99 —102	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	... — ...	... — ...	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14¾— 15¼	14¾—15¼	15 1/16	14¾
75,000	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph	10	¾%	2 %	⅝%	⅝— ⅞	¾— 1	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	6½— 7⅛	6½— 7⅛	7⅛	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	5 — 6	5½— 6½	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	103 —106	104 —107	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref....	5	7 %	...	...	8½— 9⅛	8½— 9⅛	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	9 — 10	9 — 10	...	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5½— 5⅝	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	6 %	6½— 7⅛	6½— 7⅛	...	...
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	4½%	...	...	108 —111	108 —111	110	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000...	10	10 %	6 %	4 %	7½— 8½	8 — 9	8⅝	8½
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12 — 13	12 — 13	12⅞	12⅝
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	123 —128	124 —129	128	126
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	4 %	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11 — 12	11 — 12	...	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	107 —110	107 —110	...	...
26,100	Edmundson's Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	99 —102	99 —102	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1 — 1½	1¼— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	6 %	...	3½— 4½	4 — 5	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	99 —101	99 —101	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	14 — 15	14 — 15	15	14⅞
220,000£	Do. 4½% First Mortgage Debenture Stock	...	4½%	...	...	111 —114	111 —114	...	...
220,000	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 98	96 — 98	97½	...
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	14½— 15½	14½— 15½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	14⅝	14⅜
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8 — 9	8 9/16	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	2	...
50,000	Do. do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	3 — 4	3 — 4	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	12 %	13 %	12 — 13	12 — 13	12 7/16	12

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid. Dividends marked ‖ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange. ‖ Dividends paid in deferred share warrants, profits being used as capital.

better feeling in every department, with the result that prices have

speaking generally, a good one.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Sept. 5th.	Closing Quotation Sept. 12th.	Business done week ended Sept. 12th, 1900. Highest	Lowest.
		‡							
65,000	Aluminium shares, Nos. 1—65,000	1	10 %	20 %	...	2¾— 3	2¾— 3	...	...
90,000	Do. 4½ % 1st Mort. Deb. Stock Red.	Stock	...	...	...	96 —101	96 —101	...	...
30,000	British Electric Traction	10	...	6 %	...	14½— 15½	14½— 15½	15½	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12 11/16	...
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	123 —126	123 —126	...	...
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	⅜— ½	⅜— ½	...	...
50,300	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	⅝— ¾	⅝— ¾	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	97 — 99	97 — 99	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	15 %	15 %	20 %	11 — 12	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,000 ...	5	...	...	...	5⅞— 6¼	5⅞— 6¼	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	3	3 %	5 %	...	1⅞— 1⅞	1⅞— 1⅞	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛— 2⅛xd	2⅛— 2⅛	2 3/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	106 —111 xd	106 —111	...	...
50,000	Do. do. 4½ % 2nd Deb. Stock Red	Stock	...	...	...	101 —103	101 —103	...	...
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	12½ %	15 %	15 %	12½— 13½	12½— 13½	13	12⅝
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 5⅝	5 — 5½	5¼	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	S ock	...	...	...	110 —114	110 —114	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10⅜	10⅛
61,033	Do. do. Pref. half-shares	5	...	...	...	4⅝— 5¼	5 — 5½	5⅜	5¼
71,447	Do. do. Def. do.	5	...	...	...	4⅝— 5¼	5 — 5½	5 3/16	...
855,000	City and South London Railway	Stock	1⅞ %	2⅛ %	1⅞ %	57 — 60	57 — 60	59	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	5 — 6	5 — 6	5½	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	6 %	7½ %	3¾— 4¼	3¾— 4¼	4	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —102	99 —102	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	6 %	1⅜— 2⅛	1⅜— 2⅛	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	6 %	3½— 4½	3½— 4½	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	90 — 92	90 — 92	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1⅞— 2⅛	1⅞— 2⅛	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	7 %	...	2⅜— 3¼	2⅜— 3¼	...	...
140,300	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	102 —105	102 —105	...	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	7 %	7 %	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	11½— 12½	12 — 13	12½	...
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5 — 5⅛	5 — 5⅛	5 1/16	5¼
50,000	Do. do. do. 4½ % Mort. Deb. Stock...	Stock	4½ %	...	...	108 —112 xd	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	...	...
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3¼ %	3¼ %	3¾ %	8⅜— 9	8⅜— 9	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	12¾— 13¼	13 — 13¼	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	35 — 39	35 — 39	36	...
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	...	101 — 104	101 —104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	10½— 11½	10½— 11½	...	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5¼— 5⅝	5¼— 5⅝	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	92 — 95	91 — 94	93	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½ % Debentures of £100, 102—105.
National Electric Free Wiring, 12/6 paid, ⅜—½.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 17—18 xd.
Do. do. Pref. (£10 pd.), 10—10½ xd.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 % £5 (fully paid), 6¾—7¼. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 17½.

Bank rate of discount 4 per cent. (July 19th, 1900).

MARKET QUOTATIONS, Wednesday, September 12th.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33	£33	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17	£17	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25 10	£25 10	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks ..	per lb.	3½d.	3½d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	65/-	68/-	3s. dec.
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..

METALS, &c.				
b Aluminium Wire, in ton lots ..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots	per ton	£80 to £150	£80 to 150	..
c Brass (rolled metal 2" to 12") basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8¼d.	8¼d.	..
c ,, Wire, basis	per lb.	8¼d.	8¼d.	..
c Copper Tubes (brazed) ..	per lb.	11½d.	11½d.	..
c ,, ,, (solid drawn) ..	per lb.	11d.	11d.	..
g Copper Bars (best selected) ..	per ton	£85	£85	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£85	£85	..
g ,, Rod	per ton	£85	£85	..
e ,, (Electrolytic) Bars ..	per ton	£93 10	£93 10	..
e ,, ,, Sheets ..	per ton	£92	£92	..
e ,, ,, Rod ..	per ton	£85 10	£85 10	..
e ,, ,, H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	3/-	3/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/6	8/6	..
h India-rubber, Para fine	per lb.	3/11½ to 4/2½	3/11½ to 4/2½	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	71/9	71/9	..
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£12 15	£12 15	..
g Lead, English Ingot	per ton	£17 15 to £18	£17 17 6 to £18	..
g ,, ,, Sheet	per ton	£19	£19	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 5	£9 5	..
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, medium ..	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, large ..	per lb.	3/8 to 7/3	3/8 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£3 13 6	£3 13 6	..
p Silicon Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15	to £40	..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£140 to £141	£140 to £141	..
g ,, foil	per lb.	2/-	2/-	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb b'ndl's	per lb.	9½d.	8½d.	½d. inc.
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5¾d.	5¾d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne ord.)	per ton	£24 5 nett	£24 5 nett.	..

Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

NEW BUILDINGS OF THE ST. OLAVE'S UNION, LADYWELL.

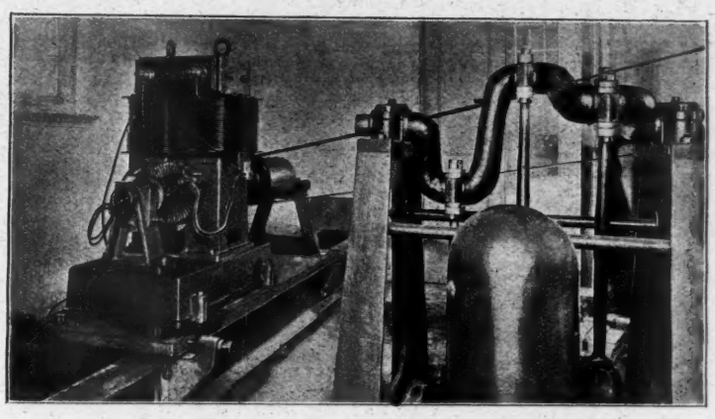
On July 12th the Prince and Princess of Wales formally opened the new buildings that the Guardians of St. Olave's Union, Southwark, have had erected at Ladywell for the accommodation of the aged and infirm poor of their district. The idea of separating the deserving and aged poor from the wastrells and ne'er-do-wells is a new departure of poor law administration, and credit should be given to the Guardians of St. Olave's for being the first public body to initiate a more humane policy than has hitherto existed in the treatment of their poor. These new buildings have been erected upon a site of about 35 acres to the designs of Messrs. Newman & Newman, architects to the board, at a capital outlay of £216,893. The establishment provides accommodation for 812 inmates, and is fitted up on a most liberal scale, according to the most modern ideas.

The buildings are lighted throughout with the electric light, the fittings generally consisting of a bronzed brass tube carrying the shades and lamps, and suspended by a ceiling plate in such a manner that they are free to swing in any direction, and that without exposing any wires or hook. The system of wiring is from distributing fuseboards and switches situated in the attendants' room on each floor of every block, all the lights being separately controlled from these points. The dining hall has 20 pendants of four lights each, of a "corona" pattern.

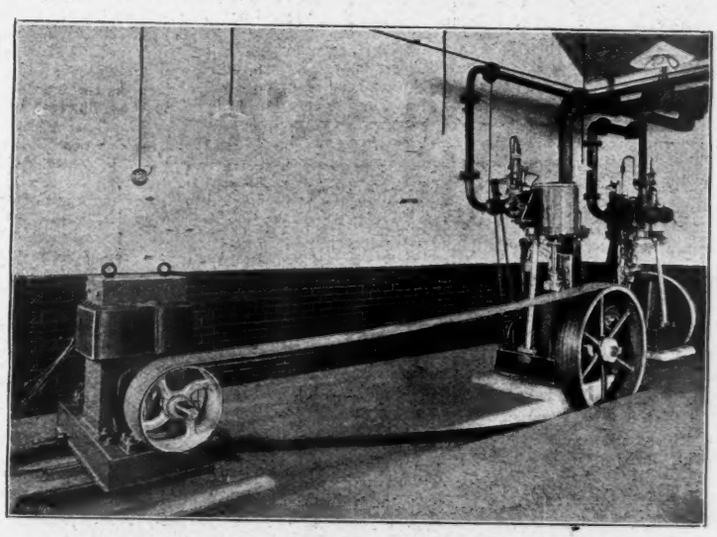
The mains are run from the engine room under the corridors to supply the main buildings, and in cast-iron pipes to the other separate buildings. There are, in all, 1,765 16-c.p. lamps installed. In the engine room there are three of Mackie & Co.'s 35-kw. dynamos driven by belts from three Robey high speed vertical engines, as shown in one of our views; provision has been made for a fourth engine and dynamo. The switchboard, which we illustrate, consists of a mahogany frame forming a room and containing four enamelled slate panels, three of which contain a double-pole main switch, fuses, instruments, &c., for each engine, and the fourth is ready for the fourth engine; all these main switches are connected to bus bars from which the distributing mains are led.

Electric motors are used to distribute power wherever required; there are two motors driving the drying fans, one motor driving the ironing machine, one motor driving the two hydros, one motor driving three washing machines, &c., and one small motor driving the foul washing machine in the laundry.

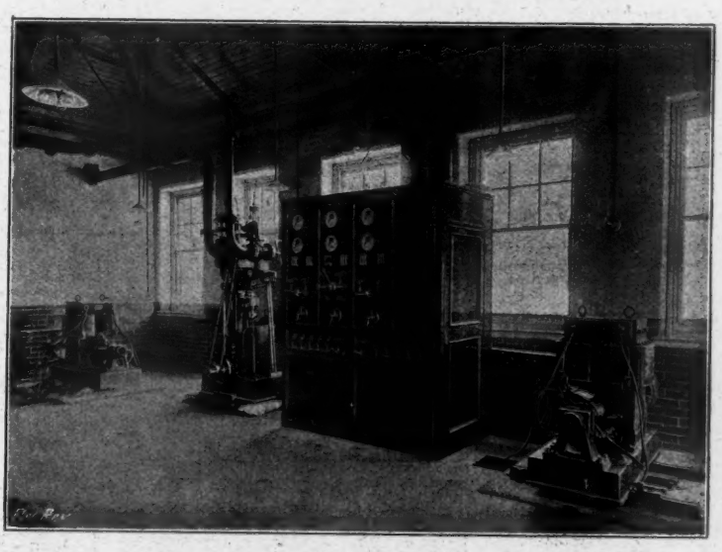
The water to supply the whole of the buildings is pumped up by a motor to the top of the water tower, and a motor drives the hydraulic pump, of which we give a view, for Messrs. Waygood's lifts. All these motors were made by Messrs. Mackie & Co., who were responsible for the whole of the electrical installation.



St. Olave's Union, Ladywell.—Motor-Driven Force Pump.



St. Olave's Union, Ladywell.—Engine and Dynamo.



St. Olave's Union, Ladywell.—Switchboard.

THE MACHINISTS' STRIKE IN AMERICA.

This threatened trouble in America appears now to be averted on, says the *Engineering Magazine*, lines of permanence. The American settlement, contrary to the usual ending of strike troubles there, seems to have been brought about before any extensive strike had really commenced, and it appears to have been based very much on the English settlement of '98. It is at least satisfactory to find that the outrages of the St. Louis trouble, and the economic waste of our own peaceable, but long strike, have not been repeated.

The agreement arrived at is binding upon all members of the National Metal Trades' Association, and the International Association of Machinists. The Board of Arbitrators met at Chicago, and the agreement of March 17th was accepted by both parties, and signed on March 31st. As a preliminary the strikes already in progress at Paterson and at Cleveland were declared off as regards the above two parties, and strikes at other shops outside the National Association were to be declared off where such shops agreed to the settlement to be arrived at. Under the agreement a "machinist" is defined as a competent general workman, floor hand, lathe hand, vise hand, and so on, through other machine tools—planer, shaper, boring mill, &c., or a competent die sinker, tool maker or linotype hand. To be competent, he must be able to complete a piece of work in his own line within a reasonable time from the drawing only as guide, and he must have served four years at the trade or else have served a regular apprenticeship.

Competency is to be decided by the employers, as they are

responsible for the work done, so they are free to elect whether a man may be considered competent. There is, however, some right of appeal against any decision of incompetency. Overtime to 10 p.m. ranks as time and quarter; from 10 to 12 p.m. it ranks as time and half, and after 12 midnight and on Sundays and legal holidays time is doubled, except in case of emergency where shop machinery breaks or runs down, Sunday work is to be at time and half only. Such repairs refer only to the employés' own machinery. Such rates for overtime do not apply to regular night gangs, and no reduction is to be made on existing rates already paid in excess of the above.

Apprentices are allowed at the rate of one for the shop and one to each five machinists. Where already in excess of this allowance, no change is to be made, but the ratio is to be allowed to correct itself by lapse of time. There is to be no discrimination against Union men, and all men are to be free to join a Union as they may think fit, but they must work harmoniously with all men, whether Unionists or not.

A man shall be free to leave his employ, but there must be no collective action taken in any matter until the matter in dispute has been dealt with under the terms of the Chicago agreement of above date.

The week is 57 hours from and after six months from the date of the joint agreement, and 54 hours after 12 months from date. These are the nominal English hours, in concession for which no restrictions are to be placed on management or shop output, and—acme of honesty!—a fair day's work will be given for a fair day's pay. That this clause has been inserted rather points to the fact of more or less interference with shop production and management, the subjects that underlay the English trouble of 1897—a trouble that we have lately been informed is not quite so much obliterated as we had hoped and thought. The gains claimed by the machinists are national recognition of their association, limitation of apprentices, definition of a machinist, shorter hours, and adjustment of overtime and rates paid for it.

We see that the working hours in America are thus nominally 54, and will soon not exceed this. We do not hear of examples where the hours are less than 54, as is so often the case here, but we believe there are now some few American shops working less than 54 hours. In Germany the hours of the best shops are about 58½. In Australia 48 hours is still universal, we believe, and in other countries hours are longer.

STEEL: ITS PROPERTIES AND TESTS.

II.

All the standard specifications, except that for steel rails, give limits of tenacity. Structural steel, boiler plate and rivets, and fish-plates, are allowed a range of 10,000 lbs. per inch in the three qualities of rivet, soft and medium, for bridge and shipwork, and of flange, fire box, and extra soft boiler steel, the first set being 50,000 to 60,000, 52,000 to 62,000, and 60,000 to 70,000, and the second set being 55,000 to 65,000, 52,000 to 62,000, and 45,000 to 55,000 respectively. For other specifications a minimum limit is laid down so as to secure necessary strength, although the elastic limit is the true index of the working capacity, and is every day receiving better recognition. Practically, the elastic limit is not easy to define, but it never falls below half the ultimate tensile strength which may be used to indicate the approximate elastic limit. The yield point should be noted. It is observed in commercial testing and forms a useful check, on the assumption that the elastic limit is not less than half the ultimate tenacity.

Elongation is taken on lengths of 8 inches in structural steels, boiler and rivet steels and splice bars, but on 2 inches in castings, axles, forgings and tires. Modifications are allowed for certain thin or thick materials.

Elongation is a most important item in a test, because it is a practically sure index of ductility, and a safe check upon too high a percentage of hardening constituents. It is an easily made test, moreover, and thus valuable for the rapid appreciation of a large output.

Contraction is included for axles, forgings and castings, which are tested by a turned specimen, but is omitted from tires, such being usually not annealed and of high carbon. The microscopic examination of steel has proved that the proper heat treatment necessary to bring out the best physical properties is invariably accompanied by the highest percentage of contraction of area obtainable with the particular class of steel. *Contraction* is thus a valuable test. When contraction cannot readily be found, the cold bending test affords a valuable substitute, for a steel capable of severe cold bending proves its capacity for cold flow, and a high contraction steel will show capacity for severe cold bending, and *vice versâ*.

Drop tests are included in specifications for axles, tires, and rails, because these articles are exposed to somewhat parallel treatment in actual work.

It is necessary for fire box steel to possess a certain homogeneity, and tests for this are specified for that material to show its freedom from slag, pipe, or unwelded blow holes. A sample from a broken test specimen must not show any defective flaw or slag streak over ¼ inch long in any of the three fractures at which the test is made.

The standard turned test specimen is shown in fig. 1. It is 2 inches long on the parallel and ½ inch diameter, or one-fourth of its length, a proportion that is justified by reason of the comparatively smaller prolongation of forging than would be needed if the 8-inch length were adhered to. Much less scrap is made for the customer to pay for, and the work of machining is less, while more specimens can be taken at different locations of an important forging. Short specimens enable tests to be taken from between the webs of a crank and from a steel tire without the heating or straightening necessary for a long specimen whereby the test is deprived of its representative value. Where elastic limit is

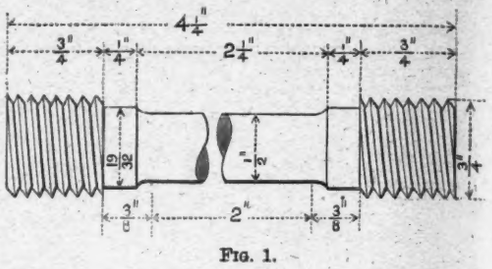


Fig. 1.

specified, the short specimen is quite suitable, for an apparatus can be attached that will read to 0·0001 inch, while for tension generally the length does not much matter as regards contraction and appearance of fracture. Elongation is, of course, greater in percentage, but this is met by stating the percentage higher on short specimens. Fig. 2 is the specimen for testing the sheared plates used in structural steel in buildings, ships and bridges. The gauge length is 8 inches, or it may be a planed or turned parallel piece, and where possible two opposite sides shall be the rolled surfaces, while rivet rounds and small bars are tested as rolled.

The number of test specimens to be taken is recommended as one from each melt or blow for axles, tires, bridge, ship and structural steel and splice bars; one from each plate of open hearth steel rolled; one from each bar of open hearth rivet steel; two from each melt of rivet rounds.

For casting or forging, each individual case is to be taken according to character and importance. Location of test specimens is not specified for bridge, ship or structural steel, open hearth rivet or plate, but for driving axles and forgings, the piece is to be taken half-

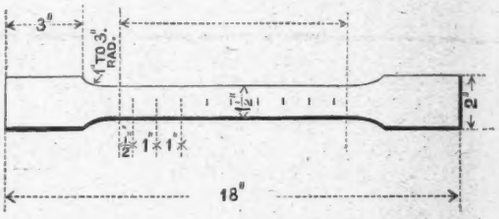


Fig. 2.

way between centre and outside of the forging. Where forgings have large ends or collars, the specimen is to be taken from an extension of the same diameter or section as that at the back of the end or collar. In hollow forging the test piece comes from the middle of the prolonged annulus.

For castings, a piece is usually cast on the main piece if a sink-head of sufficient size is not available. Pieces are cut from a drop test tire, or from a test ingot, cast with the same pouring, the test ingot being worked equally with the main ingot, while tests from sink-heads must also have received equal treatment with the piece itself before the specimen is cut out or the sink-head removed from the casting. Such are only a few of the conditions as to specimens.

A cubic inch of steel is assumed to weigh 0·2833 lb. Usually a 2½ per cent. variation from the specified weight is allowed, but there are modifications that are allowed for exceptional cases that may extend to an overweight of even 18 per cent.; wide plates, for example, being always thicker in the middle than at the sides.

Finish is so wide a subject, that the vague phrase of workmanlike finish and freedom from injurious imperfections is all that can be employed in summarising it. Branding or marking is important. The forging of a brand of iron or steel amounts to a moral, if not a legal, felony.

(*To be continued.*)

THE WEIR WATER-TUBE BOILER.

In a recent article on water-tube boilers we said:—"The one universal feature of all the water-tube boilers is the entire neglect of the necessities of combustion which they all exhibit. The pre-

440 THE ELECTRICAL REVIEW. [Vol. 47. No. 1,190, September 14, 1900.

dominating desire of the designer's heart appears to be simply to crowd all the heating surface as closely and thickly as possible upon the half-consumed fuel."

We are taken to task for this by the Weir Boilers, Limited, of Cathcart, Glasgow, who call our attention to the fact that they do not neglect the necessities of combustion, and do not crowd the tubes close upon the fire.

An examination of the illustrated pamphlets of the Weir boiler sent to us bears out their claim. Our statement was by one boiler too sweeping; the one exception, we fear, that proves the rule. The Weir boiler is built on the general lines of the torpedo boat type with a steam drum and two well-spread lower drums connected by a series of small curvilinear tubes, not unlike the Thorneycroft and Yarrow types, but possessing certain features of both. Its peculiarity is that only sufficient tubes are arranged next the fire to carry division walls of firebrick.

Between this first set of tubes and the main body of tubes is a combustion chamber, and the tubes of the main body next the chamber also carry a firebrick walling, so that the fire and hot gases do not make contact with a large area of cooling surface until they have had time to complete their combustion in a firebrick chamber. Suitable gaps are left in the firebrick to allow the gases to circulate and pass away, and we are bound to say the arrangement goes a long way to provide the refractory-lined furnace we have long urged to be necessary for the proper combustion of bituminous fuels, and to provide that intermingling of the gases that is so essential to combustion, even under the above favourable conditions.

The Weir boiler should be capable of being worked smokelessly. It differs essentially from that too numerous class of water-tube boilers in which the furnace gases rise up directly from the grate amongst the cold water pipes. The Belleville boiler, which has this fault, will smoke with the best Welsh coal. Any boiler will smoke if thus constructed, and we are glad at last to find a water-tube boiler constructed on common-sense lines in this respect. Welsh coal is supposed to be an essential in the Navy because it is smokeless, so-called. But our Navy has got a boiler that will turn out smoke even with the best of Welsh. We think it should be so boilered that there need not be any smoke from Durham or Newcastle or Wigan coal any more than from Welsh.

Combustion is a question of temperatures and engineering chemistry, yet it is due more to professors of engineering than to any other class of men that boilers have been put down of late years in which the essential conditions of combustion are most ignored.

THE INTERNATIONAL ELECTRICAL CONGRESS HELD AT PARIS, AUGUST 18th-25th, 1900.

The final meeting of the Congress took place on Saturday, August 25th, under the presidency of M. Mascart.

After recording the adoption of the term "Gauss" for the unit magnetic field and of "Maxwell" for the unit magnetic flux by the delegates, the President asked if anyone would like to make any remarks, whereupon M. Mailloux, the United States delegate, Mr. Boscham, Major John Millis, and others, addressed the meeting. M. Mailloux drew attention to the Exhibition at Buffalo next year, and expressed the hope that all present might meet again at Buffalo, and Mr. Boscham invited those present to foregather at the Exhibition at Vienna in 1903.

The President then announced that the Congress had arrived at the end of its labours, and expressed the conviction that it had fulfilled every anticipation of those who conceived the idea of a reunion of *savants* on the occasion of the Paris Exhibition. The President then proceeded to sum up briefly the work that had been done at the meetings.

Under sub-section B of their programme two papers called for special comment. These were (1) a complete review of electric lighting progress during the past 10 years by M. Blondel, who gave some information of the highest value respecting arc lamps on alternate current circuits. (2.) An elegant, clear and accurate proof by Mrs. Ayrton that the best way in which to use the arc light with continuous current from the point of view of efficiency and useful lighting effect, lay in so adjusting the mechanism that the arc formed was only one millimetre in length. In her discussion of the subject, Mrs. Ayrton adduced proofs of so conclusive a character as to evoke unanimous expressions of applause. Mrs. Ayrton's conclusions, which are contrary to the generally accepted views of engineers and scientists, and the remarkable experiments of M. Blondel, would serve, the President thought, to partly stimulate the zeal of *savants* and practical men in this field of research, and lead to great strides being made in the application of arc lighting to everyday requirements.

At the close of the President's remarks, Prof. Ayrton, in a neat speech, proposed a vote of thanks to the chairman, which was carried with acclamation, and after mutual compliments, the chairman stated that his foreign colleagues had simply heaped upon him their expressions of goodwill, and as he could not find words to express his gratitude, he declared the meeting at an end.

REVIEWS.

Modern Electric Railway Motors. By G. T. Hanchett, S.B. New York: The Street Railway Publishing Company.

This is a practical work which traces the successive steps in the development of the electric railway motor up to the most recent practice, detailing each change in construction, together with the reasons which have dictated the change. Very full information is given on the subject of field magnets and armatures, and on the winding and forming of field and armature coils.

Respecting commutators and brush-holders, the author gives some useful particulars, especially in reference to the wearing rates of mica and copper, and the precautions which should be taken to ensure that the wear of the bars and micas shall be equal. There is a very interesting chapter on motor casings in which a number of photographic illustrations are given, but which would be improved by the addition of sectional drawings.

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Vol. 47. No. 1,190, September 14, 1900.] THE ELECTRICAL REVIEW. 441

responsible for the work done, so they are free to elect whether a man may be considered competent. There is, however, some right of appeal against any decision of incompetency. Overtime to 10 p.m. ranks as time and quarter; from 10 to 12 p.m. it ranks as time and half, and after 12 midnight and on Sundays and legal holidays time is doubled, except in case of emergency where shop machinery breaks or runs down, Sunday work is to be at time and half only. Such repairs refer only to the employés' own machinery. Such rates for overtime do not apply to regular night gangs, and no reduction is to be made on existing rates already paid in excess of the above.

Apprentices are allowed at the rate of one for the shop and one to each five machinists. Where already in excess of this allowance, no change is to be made, but the ratio is to be allowed to correct itself by lapse of time. There is to be no discrimination against Union men, and all men are to be free to join a Union as they may think fit, but they must work harmoniously with all men, whether Unionists or not.

A man shall be free to leave his employ, but there must be no collective action taken in any matter until the matter in dispute has been dealt with under the terms of the Chicago agreement of above date.

The week is 57 hours from and after six months from the date of the joint agreement, and 54 hours after 12 months from date. These are the nominal English hours, in concession for which no restrictions are to be placed on management or shop output, and—acme of honesty!—a fair day's work will be given for a fair day's pay. That this clause has been inserted rather points to the fact of more or less interference with shop production and management, the subjects that underlay the English trouble of 1897—a trouble that we have lately been informed is not quite so much obliterated as we had hoped and thought. The gains claimed by the machinists are national recognition of their association, limitation of apprentices, definition of a machinist, shorter hours, and adjustment of overtime and rates paid for it.

We see that the working hours in America are thus nominally 54, and will soon not exceed this. We do not hear of examples where the hours are less than 54, as is so often the case here, but we believe there are now some few American shops working less than 54 hours. In Germany the hours of the best shops are about 58½. In Australia 48 hours is still universal, we believe, and in other countries hours are longer.

STEEL: ITS PROPERTIES AND TESTS.

II.

All the standard specifications, except that for steel rails, give limits of tenacity. Structural steel, boiler plate and rivets, and fish-plates, are allowed a range of 10,000 lbs. per inch in the three qualities of rivet, soft and medium, for bridge and shipwork, and of flange, fire box, and extra soft boiler steel, the first set being 50,000 to 60,000, 52,000 to 62,000, and 60,000 to 70,000, and the second set being 55,000 to 65,000, 52,000 to 62,000, and 45,000 to 55,000 respectively. For other specifications a minimum limit is laid down so as to secure necessary strength, although the elastic limit is the true index of the working capacity, and is every day receiving better recognition. Practically, the elastic limit is not easy to define, but it never falls below half the ultimate tensile strength which may be used to indicate the approximate elastic limit. The yield point should be noted. It is observed in commercial testing and forms a useful check, on the assumption that the elastic limit is not less than half the ultimate tenacity.

Elongation is taken on lengths of 8 inches in structural steels, boiler and rivet steels and splice bars, but on 2 inches in castings, axles, forgings and tires. Modifications are allowed for certain thin or thick materials.

Elongation is a most important item in a test, because it is a practically sure index of ductility, and a safe check upon too high a percentage of hardening constituents. It is an easily made test, moreover, and thus valuable for the rapid appreciation of a large output.

Contraction is included for axles, forgings and castings, which are tested by a turned specimen, but is omitted from tires, such being usually not annealed and of high carbon. The microscopic examination of steel has proved that the proper heat treatment necessary to bring out the best physical properties is invariably accompanied by the highest percentage of contraction of area obtainable with the particular class of steel. *Contraction* is thus a valuable test. When contraction cannot readily be found, the cold bending test affords a valuable substitute, for a steel capable of severe cold bending proves its capacity for cold flow, and a high contraction steel will show capacity for severe cold bending, and *vice versâ*.

Drop tests are included in specifications for axles, tires, and rails, because these articles are exposed to somewhat parallel treatment in actual work.

It is necessary for fire box steel to possess a certain homogeneity, and tests for this are specified for that material to show its freedom from slag, pipe, or unwelded blow holes. A sample from a broken test specimen must not show any defective flaw or slag streak over ¼ inch long in any of the three fractures at which the test is made.

The standard turned test specimen is shown in fig. 1. It is 2 inches long on the parallel and ½ inch diameter, or one-fourth of its length, a proportion that is justified by reason of the comparatively smaller prolongation of forging than would be needed if the 8-inch length were adhered to. Much less scrap is made for the customer to pay for, and the work of machining is less, while more specimens can be taken at different locations of an important forging. Short specimens enable tests to be taken from between the webs of a crank and from a steel tire without the heating or straightening necessary for a long specimen whereby the test is deprived of its representative value. Where elastic limit is

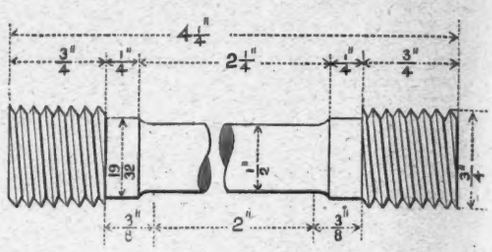

Fig. 1.

specified, the short specimen is quite suitable, for an apparatus can be attached that will read to 0·0001 inch, while for tension generally the length does not much matter as regards contraction and appearance of fracture. Elongation is, of course, greater in percentage, but this is met by stating the percentage higher on short specimens. Fig. 2 is the specimen for testing the sheared plates used in structural steel in buildings, ships and bridges. The gauge length is 8 inches, or it may be a planed or turned parallel piece, and where possible two opposite sides shall be the rolled surfaces, while rivet rounds and small bars are tested as rolled.

The number of test specimens to be taken is recommended as one from each melt or blow for axles, tires, bridge, ship and structural steel and splice bars; one from each plate of open hearth steel rolled; one from each bar of open hearth rivet steel; two from each melt of rivet rounds.

For casting or forging, each individual case is to be taken according to character and importance. Location of test specimens is not specified for bridge, ship or structural steel, open hearth rivet or plate, but for driving axles and forgings, the piece is to be taken half-

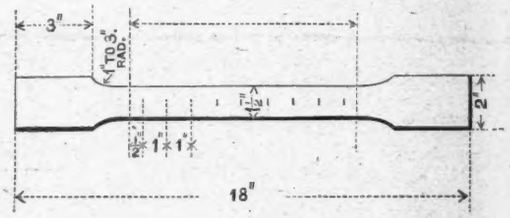

Fig. 2.

way between centre and outside of the forging. Where forgings have large ends or collars, the specimen is to be taken from an extension of the same diameter or section as that at the back of the end or collar. In hollow forging the test piece comes from the middle of the prolonged annulus.

For castings, a piece is usually cast on the main piece if a sink-head of sufficient size is not available. Pieces are cut from a drop test tire, or from a test ingot, cast with the same pouring, the test ingot being worked equally with the main ingot, while tests from sink-heads must also have received equal treatment with the piece itself before the specimen is cut out or the sink-head removed from the casting. Such are only a few of the conditions as to specimens.

A cubic inch of steel is assumed to weigh 0·2833 lb. Usually a 2½ per cent. variation from the specified weight is allowed, but there are modifications that are allowed for exceptional cases that may extend to an overweight of even 18 per cent.; wide plates, for example, being always thicker in the middle than at the sides.

Finish is so wide a subject, that the vague phrase of workmanlike finish and freedom from injurious imperfections is all that can be employed in summarising it. Branding or marking is important. The forging of a brand of iron or steel amounts to a moral, if not a legal, felony.

(*To be continued.*)

THE WEIR WATER-TUBE BOILER.

In a recent article on water-tube boilers we said:—"The one universal feature of all the water-tube boilers is the entire neglect of the necessities of combustion which they all exhibit. The pre-

their expressions of goodwill, and as he could not find words to express his gratitude, he declared the meeting at an end.

dominating desire of the designer's heart appears to be simply to crowd all the heating surface as closely and thickly as possible upon the half-consumed fuel."

We are taken to task for this by the Weir Boilers, Limited, of Cathcart, Glasgow, who call our attention to the fact that they do not neglect the necessities of combustion, and do not crowd the tubes close upon the fire.

An examination of the illustrated pamphlets of the Weir boiler sent to us bears out their claim. Our statement was by one boiler too sweeping; the one exception, we fear, that proves the rule. The Weir boiler is built on the general lines of the torpedo boat type with a steam drum and two well-spread lower drums connected by a series of small curvilinear tubes, not unlike the Thorneycroft and Yarrow types, but possessing certain features of both. Its peculiarity is that only sufficient tubes are arranged next the fire to carry division walls of firebrick.

Between this first set of tubes and the main body of tubes is a combustion chamber, and the tubes of the main body next the chamber also carry a firebrick walling, so that the fire and hot gases do not make contact with a large area of cooling surface until they have had time to complete their combustion in a firebrick chamber. Suitable gaps are left in the firebrick to allow the gases to circulate and pass away, and we are bound to say the arrangement goes a long way to provide the refractory-lined furnace we have long urged to be necessary for the proper combustion of bituminous fuels, and to provide that intermingling of the gases that is so essential to combustion, even under the above favourable conditions.

The Weir boiler should be capable of being worked smokelessly. It differs essentially from that too numerous class of water-tube boilers in which the furnace gases rise up directly from the grate amongst the cold water pipes. The Belleville boiler, which has this fault, will smoke with the best Welsh coal. Any boiler will smoke if thus constructed, and we are glad at last to find a water-tube boiler constructed on common-sense lines in this respect. Welsh coal is supposed to be an essential in the Navy because it is smokeless, so-called. But our Navy has got a boiler that will turn out smoke even with the best of Welsh. We think it should be so boilered that there need not be any smoke from Durham or Newcastle or Wigan coal any more than from Welsh.

Combustion is a question of temperatures and engineering chemistry, yet it is due more to professors of engineering than to any other class of men that boilers have been put down of late years in which the essential conditions of combustion are most ignored.

THE INTERNATIONAL ELECTRICAL CONGRESS HELD AT PARIS, AUGUST 18th-25th, 1900.

The final meeting of the Congress took place on Saturday, August 25th, under the presidency of M. Mascart.

After recording the adoption of the term "Gauss" for the unit magnetic field and of "Maxwell" for the unit magnetic flux by the delegates, the President asked if anyone would like to make any remarks, whereupon M. Mailloux, the United States delegate, Mr. Boscham, Major John Millis, and others, addressed the meeting. M. Mailloux drew attention to the Exhibition at Buffalo next year, and expressed the hope that all present might meet again at Buffalo, and Mr. Boscham invited those present to foregather at the Exhibition at Vienna in 1903.

The President then announced that the Congress had arrived at the end of its labours, and expressed the conviction that it had fulfilled every anticipation of those who conceived the idea of a reunion of *savants* on the occasion of the Paris Exhibition. The President then proceeded to sum up briefly the work that had been done at the meetings.

Under sub-section B of their programme two papers called for special comment. These were (1) a complete review of electric lighting progress during the past 10 years by M. Blondel, who gave some information of the highest value respecting arc lamps on alternate current circuits. (2.) An elegant, clear and accurate proof by Mrs. Ayrton that the best way in which to use the arc light with continuous current from the point of view of efficiency and useful lighting effect, lay in so adjusting the mechanism that the arc formed was only one millimetre in length. In her discussion of the subject, Mrs. Ayrton adduced proofs of so conclusive a character as to evoke unanimous expressions of applause. Mrs. Ayrton's conclusions, which are contrary to the generally accepted views of engineers and scientists, and the remarkable experiments of M. Blondel, would serve, the President thought, to partly stimulate the zeal of *savants* and practical men in this field of research, and lead to great strides being made in the application of arc lighting to everyday requirements.

At the close of the President's remarks, Prof. Ayrton, in a neat speech, proposed a vote of thanks to the chairman, which was carried with acclamation, and after mutual compliments, the chairman stated that his foreign colleagues had simply heaped upon him their expressions of goodwill, and as he could not find words to express his gratitude, he declared the meeting at an end.

REVIEWS.

Modern Electric Railway Motors. By G. T. Hanchett, S.B. New York: The Street Railway Publishing Company.

This is a practical work which traces the successive steps in the development of the electric railway motor up to the most recent practice, detailing each change in construction, together with the reasons which have dictated the change. Very full information is given on the subject of field magnets and armatures, and on the winding and forming of field and armature coils.

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of two Fowler engines on August 20th, 1870, offered to help in getting heavy guns up Mont St. Michel before Toul and his offer was declined. It was not till September 14th that the guns were placed in position by the usual means. So much for German red tape. The recent great progress in automobiles is largely due to the use of petrol, but the heavier oils are much used either directly in engines, or as the fuel for steam raising.

The certainty of action that still characterises the steam engine more than any other motor gives steam an advantage, despite its weight, and we read without surprise the author's numerous accounts of how traction engines get themselves and their loads out of difficulties. They either haul their loads themselves, or they wind them out of a hole by their steel hawsers, or if themselves in a fix, send out an anchor ahead and pull themselves free by steel wires. A good traction engine is a fine machine, and can do almost anything. It is a durable machine. The two Fowler engines used by the Germans in 1870 are still employed in steam-plough work. Over 8,000 traction engines were in use in Great Britain in 1894. One wonders where they can all be. In November, 1899, there were 15 Fowler and other engines sent out to South Africa. Ten were sunk in the *Denton Grange* at Las Palmas, and others were sent to replace them, but the 10 were fished up, and are doing duty in South Africa.

Armoured road trains have been of great use. The armoured railroad train has a narrow field, and becomes helpless if the rails are damaged. The traction engine can go anywhere if it is still uninjured itself. There is a good deal of general information on all kinds of automobiles, and there can be no doubt that for an army on the march the traction engine is a most valuable auxiliary. Its rate of march may be slow, but it is as quick as the general progress of an army. Indeed, the march of an army would be accelerated considerably were the unnecessary loads of the private soldier cared for by the transport department. Possibly, after the war, we may hear more of the traction engines. At present we know simply nothing.

CURRENT SPECIFICATIONS.

XXVIII.—PLUMSTEAD ELECTRIC LIGHTING.

SUMMARY.

Scope of Contract.—The equipment of the entire electric power and dust destructor station is divided into no less than 17 different contracts.

Section under Consideration.—Section C, Contract No. 9.—Steam dynamos and balancer boosters.

General Conditions.—Applicable to all sections.

Number of Steam Dynamos Required.—Five.

Output of Sets.—Two, to each develop 195 KW.; two, to each develop 97·5 KW. The other set is to consist of one steam engine with a 32·5 KW. dynamo mounted at each end.

Type of Engine.—Alternative offers will be considered:—

(*a*) For horizontal cross-compound condensing engines.

(*b*) For vertical cross-compound condensing engines.

(*c*) For high speed enclosed or semi-enclosed triple expansion or compound engines.

Speed of Combination.—For (*a*) and (*b*) 195 KW. sets, 200 revolutions per minute, 97·5 KW., 275 revolutions, and 65 KW. set, 300 revolutions per minute.

Steam Pressure Available.—180 lbs. per square inch.

Condenser.—To be supplied under separate contract, to be capable of maintaining a vacuum of 25 inches.

Position of Dynamos.—For larger sets between engine cranks, or at side of engine, at tenderer's option.

Voltage of Dynamos.—To be 510 volts at no load, and 550 volts at full load. To be also suitable for working on lighting load at 460 volts. The 32·5-KW. machine to be wound for 230 volts at no load, and 320 volts at full load.

Overload of Combination.—To be suitable for working at 25 per cent. overload for two hours without undue heating, and 50 per cent. for short periods without injurious sparking or necessary movement of brushes.

Permissible Temperature Rise.—After 12 hours normal full load run, or two hours 25 per cent. overload run, temperature rise measured thermometrically not to exceed 40° C. (72° F.) above surrounding atmosphere.

Output of Balance Booster.—To consist of four machines rigidly coupled together. Output of each balance or inner machine to be 50 amperes at 230—260 volts, and of each outer or booster machine 120 amperes at 10—100 volts.

Maximum Speed of Combination.—1,300 revolutions per minute.

Specified Date of Completion.—Section C—nine months.

Penalty for Late Completion.—*One per cent.* per week.

Terms of Payment.—As work proceeds up to 75 per cent. of value of plant delivered on site until balance of 25 per cent. of executed work is equal to 10 per cent. of total contract sum. Thereafter 90 per cent. of value of work completed until completion, when an additional 5 per cent. of total sum is payable. The remaining 5 per cent. is due at end of period of maintenance.

Stipulation as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages paid to Workmen.—Unsatisfactory, see comments below.

Arbitration Proposals.—Satisfactory.

Date on which Tenders are due.—September 19th, 1900.

This scheme has been prepared by the chief electrical engineer to the Vestry, Mr. J. B. Mitchell, and as will be noted, alternative offers are invited for different types of steam engines.

At the present time it is curious to notice the absence of any one fashion in regard to traction plants. Engineers seem to have rather an open mind on the subject, and while some are inclined towards the horizontal types general in the United States, others prefer the enclosed high-speed types which have become such favourites for lighting work. In addition to the steam dynamos, this specification asks for two balancer boosters so arranged that when desired they can be directly coupled so as to form the usual four-armature machine.

The general conditions appear to be a compromise. In some of the clauses we recognise the spirit, if not the letter, of the model clauses agreed upon between the Municipal Electrical Association and the Electrical Plant Manufacturers' Association, others are mere copies of those adopted by the London County Council, and commented upon in our last issue.

Thus we have a fair arbitration clause which may be accepted without reservation, and stipulations respecting drawings which are very reasonable. This clause reads:—

> The contractor shall, at his own expense, supply to the vestry *three copies* of the drawings necessary for the works under the contract, but *shall not be called upon to furnish constructional details further than in the opinion of the electrical engineer are required for the purposes of the contract.* If the contractor shall be called upon to supply additional copies of the drawings, *they shall be paid for at a fair price to be arranged.* The electrical engineer shall, in addition, have the right at all reasonable times to inspect any drawings of any portion of the plant contracted for at the works of the manufacturer.

The clause referring to the powers of the engineer to reject materials or vary work is also fair. The portion relating to the first question reads:—

> A decision of the electrical engineer to reject materials, or require workmanship which is in his opinion defective to be amended, shall be obeyed by the contractor. If the contractor shall so desire, and of such desire shall give notice in writing to the Vestry within 72 hours after receiving notice from the electrical engineer, the question involved in any such decision of the electrical engineer may be submitted to arbitration, as herein provided. The contractor shall not under these circumstances cease to proceed with the execution of the contract, to the prejudice of the Vestry.

It is also expressly stipulated that the refusal of the engineer to grant a final certificate shall be a suitable matter for arbitration, a matter which is sometimes excluded, and which causes thereby a needless amount of friction. The wording might well be copied by other engineers.

> When the contract works shall be completed, as referred to in the clause relating to payments, the contractor shall be entitled to call upon the electrical engineer for a certificate to that effect. In case of the refusal of the electrical engineer to grant such certificate when called upon by the contractor so to do, this refusal shall be subject to appeal under the arbitration clause herein contained.

An unusual stipulation is:—

> The contractor shall provide a suitable office furnished with the requisite desk, cupboards, and seats, for the storage of the drawings and accommodation of the electrical engineer during the progress of the works, in some convenient position, near the site thereof.

Up to this point, the conditions attached to the specification are fair and reasonable, but when we state that what are known as the London County Council labour clauses have been adopted in their entirety, it is sufficient to justify our urging all tenderers to refuse to accept the contract unless they are abandoned. To do this, runs the risk of having a tender rejected without consideration, but it is

express his gratitude, he declared the meeting at an end.

" hide bound in red tape," but we learn here that the driver

nevertheless necessary. In the instructions to tenderers we find :—

Tenders must be on the annexed form, and, together with the schedules of prices, must be filled up, completed and returned, signed by a principal or authorised agent. *The whole requirements must be complied with, or the tender will be disqualified.*

The contract will bind the contractor to pay to all workmen (except a reasonable number of his legally bound apprentices) employed by him, wages, and wages for overtime at rates not less, and to observe, and cause to be observed by such workmen, hours of labour not greater than those provided for by the schedule "B" to the form of contract.

We advise all tenderers stating in their offers that they cannot agree to the clauses granting to the Vestry power to dictate the rates of pay and the hours and conditions under which they employ their own workmen, and also to make quite clear that they do not intend either to publish in their workshops the rates of pay specified to be paid under this contract, or to grant the officials of the Vestry access to their private time and wages books. We stated in dealing with the Horton Asylum specification last week the reasons why we consider these claims unjustifiable, unworkable, and unfair.

The principal addition to the County Council labour clauses is one more clearly defining what is meant by sub-contracting.

According to the definition now given, the contractor is at liberty to purchase goods which can be obtained wholesale in the open market, but the clause applies to all plant specially manufactured for this contract. This exception may lead to the further question as to whether such articles as steam engines made to a manufacturer's standard design would come under this heading, as they could certainly be bought wholesale if desired. The clause is important, and may seriously affect the risks to be met by the contractor. It reads :—

No sub-contract shall operate to relieve the contractor from any of his liabilities or obligations, and *the contractor shall be responsible for all the acts, defaults, and neglects of the sub-contractor as fully as if they were the acts, defaults, and neglects of the contractor,* and there shall be inserted in *all such sub-contracts* a covenant by the sub-contractor that *he will pay all workmen employed by him in or about the execution of such sub-contract rates of wages not less,* and observe and cause to be observed by such workmen, *hours of labour not more,* than the rates of wages and hours of labour following, that is to say, as regards all work done upon a site, any part of which is within a radius of 20 miles, measured in a straight line from Charing Cross, *the rates of wages and hours of labour set out in the first schedule hereto as applicable to work done within such radius,* and as regards all other work such rates of wages and hours of labour *as at the date of the sub-contract are recognised by associations of employers and Trade Unions, and in practice obtained in the several districts where the work is done,* and such rates of wages and hours of labour shall be inserted in a schedule to the sub-contract, but *in no case shall such rates of wages be less, or hours of labour greater than those set out in the wages and hours schedule of this contract between the Vestry and the contractor,* and in case of any breach by the sub-contractor of the covenant as regards rates of wages and hours of labour to be inserted in any sub-contract (and notwithstanding the connivance of the contractor in or condonation by such contractor of such breach or any prior breach) *the contractor shall for every such breach as regards the rates of wages on demand pay to the Vestry* as liquidated damages, and not as a penalty, the sum of £5, and shall for every such breach as regards the hours of labour on demand pay to the Vestry as liquidated damages, and not as a penalty, for each day on which such breach shall be committed, and for each workman in respect to whom it shall have been committed, *the sum of 5s. per hour for every hour during which such workman shall have been employed by the sub-contractor beyond the maximum number of hours* during which under the terms of the said covenant he ought to have been employed. *Any such sub-contract* shall also provide that the *sub-contractor shall* at all times during the continuation of the sub-contract, *display or keep displayed* on the works and in every factory or workshop, or place occupied or used by the sub-contractor in or about the execution of the sub-contract, *in a position in which the same may be easily read by all workmen employed by the sub-contractor in or about the execution of the sub-contract, a clearly printed or written copy of the said schedule;* and that *the sub-contractor shall at any time,* and from time to time during the continuance of the sub-contract, whenever called upon so to do by the clerk of the Vestry *produce to such officer or officers of the Vestry* as the clerk may direct *the time and wages books and sheets of the sub-contractors,* to show whether or not this stipulation has been and is being complied with.

Provided that this clause shall not be construed as prohibiting the sub-contractor without the consent of the Vestry from purchasing or sub-contracting for the supply of any materials, articles or things required for the execution of the contract which are ordinarily to be purchased wholesale in the market or of wholesale merchants or manufacturers.

Tenderers should remember that it is only by united action that they can meet demands of this character ; if they would all refuse to agree to them, local authorities would soon discover that stipulations of this character would have to be modified. It is well known that "a man is often more honest than his creed," and on the principle that honourable men would refuse to take advantage of such manifestly unfair conditions as the above, contractors often run the risk of their enforcement ; we contend that this is an unwise course to adopt, and that it is far better to take the clauses as we find them, point out their manifest injustice, and refuse to agree to any which cannot be honourably complied with.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1900.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester and Birmingham, to whom all inquiries should be addressed.

15,225. "Improvements in electric arc lamps." H. Bremer. Dated August 27th. (Complete.)

15,227. "Improvements in or relating to machinery for the production of electrical energy." H. S. Elworthy. Dated August 27th.

15,234. "Improvements relating to rotary motors." R. Berthon and M. Berthon. (Date applied for under Patents, &c., Act, 1883, Section 103, February, 1900, being date of application in France.) Dated August 27th.

15,246. "Improvements in the manufacture of electrically-conducting bodies." E. Sander. Dated August 27th.

15,265. "An improved joint box for electric cables." G. A. Clark. Dated August 28th.

15,285. "Improvements in systems of electrical distribution." The British Thomson-Houston Company, Limited. (A. D. Lunt, United States.) Dated August 28th. (Complete.)

15,298. "Improvements in wireless telegraphy." C. E. Wilson. Dated August 28th. (Complete.)

15,313. "Improvements in automotor trolleys for electric current." P. B. L. Lombard-Gerin. Dated August 28th. (Complete.)

15,332. "Improvements in apparatus for stopping, starting, and reversing electric motors." W. L. Wise. (The Skodawerke Actien-Gesellschaft, Austria.) Dated August 28th.

15,334. "Improvements relating to switches and apparatus for use in starting, controlling, and reversing electric motors." A. H. Adams. Dated August 28th.

15,378. "Improvements in means for generating alternating electric currents." The British Thomson-Houston Company, Limited. (A. D. Lunt, United States.) Dated August 29th. (Complete.)

15,379. "Improvements in regulating dynamo-electric machines." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated August 29th. (Complete.)

15,380. "Improvements in systems of electrical distribution." The British Thomson-Houston Company, Limited. (C. P. Steinmetz and W. Le R. Emmet, United States.) Dated August 29th. (Complete.)

15,381. "Improvements in thermal electric cut-outs." The British Thomson-Houston Company, Limited. (W. Le R. Emmet, United States.) Dated August 29th. (Complete.)

15,382. "Improvements in systems of electrical distribution." The British Thomson-Houston Company, Limited. (C. M. Green and J. G. Callan, United States.) Dated August 29th. (Complete.)

15,404. "Improvements in incandescent electric lighting devices." W. P. Thompson. (The Voltohm Electrizitats Gesellschaft, A.G., Germany.) Dated August 29th.

15,419. "Improvements relating to the supply of current to electric vehicles by inductive means." R. Haddan. (E. Sussmann-Kellborn, Germany.) Dated August 29th.

15,457. "Improvements relating to the production of electrical conducting bodies specially applicable for the use in electric incandescent lamps." E. Sander. Dated August 30th.

15,470. "Process of forming metallic electrode plates." A. J. Boult. (E. Andreas, Germany.) Dated August 30th.

15,473. "Process for the forming of electrodes." A. J. Boult. (E. Andreas, Germany.) Dated August 30th.

15,475. "Improvements in and in connection with the distribution of electrical supply." F. E. Beeton. Dated August 30th.

15,479. "Improvements in electric arc lamps." F. E. Beeton. Dated August 31st.

15,480. "Improvements in or relating to overhead systems for the transmission of electrical energy." W. Routledge. Dated August 31st.

15,483. "Improvements in wireless telegraphy." S. G. Brown. Dated August 31st.

15,579. "A new or improved rotary motor." W. J. Munden. (J. Bottin, Persia.) Dated August 31st.

15,591. "Improvements in automatic interrupters for electric circuits." A. J. Boult. (F. Katzenstein, Belgium.) Dated August 31st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

19,876. "Improvements in the electrolytic separation of zinc from zinc oxide." O. J. Steinhart, J. L. F. Vogel and H. E. Fry. Dated September 19th, 1898. Zinc is obtained electrolytically from zinc oxide by dissolving the oxide in molten zinc chloride (either alone or with sodium chloride) contained in a vessel heated externally to a temperature above the melting point of zinc. The current is passed between carbon anodes dipping into the molten mixture and a layer of

fused zinc forming the cathode at the bottom of the vessel. Oxygen is given off at the anode and zinc is liberated at the cathode. The process is rendered continuous by adding fresh zinc oxide as the oxide becomes dissolved in the molten chloride. The chloride takes no part in the reaction. The provisional specification states that instead of zinc chloride another suitable salt capable of acting in a like manner may be used. 1 claim.

20,208. "Improvements in electrical signalling apparatus for railways." F. Pegelow. Dated September 23rd 1899. Relates to electric signalling apparatus for preventing collisions between vehicles approaching each other on railways, the apparatus also enabling telegraphic or telephonic communication to be established between the drivers. Two insulated conducting rails are mounted between the ordinary rails, so as to make contact with one of two rollers, according to the direction of motion of the vehicle. Each section of the rails is equal to, or more than the minimum permissible distance which one vehicle may approach to another, and the sections of each rail are arranged to break joint with those of the other. The rollers and the ordinary wheels are connected through a switchboard to the battery and alarm on the vehicle. The board is provided with two switch levers each having two insulated contact-making plugs. One lever is set to connect certain contacts if the vehicle is moving forward, other contacts if going backwards, and other contacts if stopped. The other lever is set to connect the contacts according, as to which roller is on the rails. When two vehicles approach each other until they come on the same section of rail, or when one vehicle moves on to such a section occupied by a stationary vehicle, the alarm on the moving vehicle or vehicles is operated. When the alarms have been operated, and the vehicles brought to a standstill, the alarms may be cut out, and a telegraphic or telephonic apparatus switched into the circuit. 3 claims.

20,972. "An improvement in the adaptation of the telephone to electric bell pushes such as are used in ordinary bell and indicator systems for private houses, offices, hotels, and the like." G. L. Anders and A. J. Wilson. Dated October 5th, 1898. Telephone transmitters and receivers are constructed so that they may be contained in an electric bell push casing, and readily removed from or adapted to casings of any design without disturbing the electric connections. The microphone transmitter is contained in the part which is attached to the wall, while the receiver and bell push are contained in the part which, when in the position of not being used, may, by means of a metal ring holding clips and a spring contact, break the talking circuit and establish the bell circuit. The key for controlling the talking circuit may be carried on the receiver and operated by the finger, and may be further made to control the bell circuit. 4 claims.

21,043. "Improvements in electric meter systems." The British Thomson-Houston Company, Limited. (E. W. Rice.) Dated October 6th, 1898. Relates to current meters. A maximum demand indicator consists of a stylus moved proportionately to current supplied, and marking on a stationary surface. In the form described the stylus is a pencil or pen carried by a lever which is acted on by an adjustable spring, the iron core of an ironclad solenoid, and the piston of the dashpot. It marks on a graduated paper held by clips. A bristle marking on smoked glass may be used. The solenoid may be connected in series with the field coils of a watt-hour-meter in a supply main. 4 claims.

21,201. "Improvements in hydro-pneumatic accumulators." J. S. Stevens, C. G. Major and E. C. Stevens. Dated October 8th, 1898. Relates to that class of hydraulic accumulators in which the water is pumped into a reservoir containing air, so as to store energy by the compression of the air. A valve is arranged to restrict the water outflow when the level in the reservoir falls below a certain point, and to close it entirely or nearly so before any air can escape. The valve may be in the form of a cap passing over a rose, or of the double-beat pattern. A displacement block of stone or other suitable material is attached to the valve, and their combined weight is nearly balanced by weights, the effect being that, when the water falls below a predetermined level, the valve descends and gradually cuts off the flow through the rose. If the supply pumps are working, the valve acts as a governor restricting the supply to the amount delivered by the pumps. A bye-pass pipe and cock are provided for restoring the pressure in the pipe when necessary. 2 claims.

21,216. "An improved trolley for taking electric current applicable to the electric traction of vehicles, boats, and the like." S. Lombard-Gerin. Dated October 8th, 1898. Relates to means for supplying current for electric traction on rail or road, or for propelling boats by means of an independent self-propelling trolley connecting to the vehicle, &c., by a flexible cable. The trolley runs on one conductor from which it may take current, and drags a second trolley by means of the cable, through which the return may be made to one or more conductors, according to the nature of the current. The trolley carries a motor by which it is propelled. 3 claims.

21,224. "Improvements in or relating to electric clocks or watches." E. Rosi and G. Vaccetti. Dated October 8th, 1898. The first wheel of the movement is a ratchet wheel and is driven by a pawl on the balance arbour. A detent pawl hitting a strip terminal makes and breaks the circuit of an electro-magnet, the armature of which is a forked lever engaging an eccentric pin on the balance. The lever impels the balance when attracted, and is reset by the return swing after the detent pawl has jumped from the contact strip into another tooth of the ratchet wheel. 3 claims.

21,233. "Improvements in apparatus for coating metal articles by electro-deposition." J. Thornton and T. R. Canning. Dated October 8th, 1898. Relates to apparatus in which articles are burnished during coating. It consists of a rotating wood barrel, which may be hexagonal in shape, and have one removable side. It is provided with perforations and wood or other non-conducting trunnions, which are carried on brackets and held in position by blocks sliding in suitable guides. The brackets are mounted in a tank. Through one or both of the trunnions there passes an axial connecting bar or bars, connected up by the pivoted contact plate pivoted pin and conducting strip to the negative cable. Inside the barrel the bar is in electrical contact with an end metallic plate, and the latter with conducting strips extending around the inner surface of the drum to the metallic end plate. The liquid level is a short distance below that of the bar. By throwing back the contact piece the barrel can be removed, and a fresh one substituted for it. 3 claims.

21,307. "Improvements in the production of incandescent materials suitable for use in electric lighting." S. Pitt. (The Pharmaceutisches Institut Ludwig Wilhelm Gans.) Dated October 10th, 1898. Relates to incandescent lamps. Filaments are made from osmium, iridium, rhodium, ruthenium, or alloys of these, formed in thin layers by applying organic compounds of such metals to temporary supports, burning them on and then detaching the metallic lustres thus produced by applying solvents which attack the supports, as described in Specification No. 17,893, A.D. 1894. Before applying the solvents the metallic lustre is now coated with tough collodion, gutta-percha solution or like varnish to strengthen it. This coating is removed from the filament by burning off, or by a solvent after which the metal may be coated with an organic compound of an earthy oxide, and this burnt on. The temporary support is made of porcelain, glass, metal, or other material, coated with an organic compound of a base metal, or with a flux which may contain borosilicate or phosphate of soda; this is burnt on, producing a coating which can be removed by acids after the metallic lustre has been formed on it. The metallic lustre may be painted on in strips so as to directly form a filament or a net, or formed in sheets as described in the preceding Specification, No. 21,306, A.D. 1898, and may be thickened by electro-depositing. Such sheet, coated with collodion may be rolled up to form a solid filament, or on a thread core to form a tube. 6 claims.

21,317. "Improvements in magnetic separating apparatus." A. M. Clark. (Metallurgische, Gesellschaft, A. G.) Dated October 10th, 1898. A separator suitable for the treatment of material of low magnetic power may comprise three magnets having pointed poles, the poles being covered by adjustable caps of non-magnetic material. The polarities of the poles of magnets F.G. are opposed to those of the poles of the magnet are opposite to those of the poles of the magnet contiguous to them. The materials are supplied to the poles from hoppers, the supplies being regulated by means of adjustable bars. The edges of the poles are brightly polished, or covered with polished steel plates. In treating mixtures containing garnet, iron ore, or minerals of comparatively strong magnetic power, the magnet alone may be provided with a coil. 3 claims.

21,364. "Improvements in battery solutions." H. Blumenberg, jun. Dated October 11th, 1898. An electrolyte which may be used in conjunction with a zinc electrode is made up of a mixture of a chlorate of an alkali or alkaline earth mixed with a bisulphate of an alkali or alkaline earth. The preferred mixture consists of sodium chlorate and sodium bisulphate. 2 claims.

21,374. "Improvements in rheostats or electric heaters." E. O. Raster. Dated October 11th, 1898. A heating or regulating existence is built up of straight strips of carbon separated by air spaces, and connected in series so that current may be passed through the whole length of the strips by interposed blocks, alternately of glass or other non-conductor, and carbon aluminium, or other non-oxidising conductor. The strips are arranged in two rows between metal bars which have insulating linings, and are attached to end pieces; the metal bars carry central metal partitions, covered with insulating material, against which the series of strips are pressed by screws, carried by the end pieces, and fixed by other screws. The series are electrically connected across the partitions by aluminium bridges. Some of the interposed metal blocks are provided with screws to hold conductors for connecting different parts of the resistance. A motor regulating switch is described having a row of contacts connected with such a resistance, and a contact-arm acted on by a spring which tends to place it on an unconnected end stud; when the arm is moved to the other end stud, which cuts out all the resistance it is engaged and held by a latch. A lever, acted on by an electro-magnet in the circuit, is dropped if the current is stopped, and in this case raises the latch so that the switch arm is freed and returns to the disconnecting stud. 6 claims.

21,410. "Improvements in controlling switches and apparatus for electric motors." R. Hutchison. Dated October 11th, 1898. Relates to controllers for motors, especially applicable when two are used on tramcars. Electro-magnetic means are provided for locking the switch arm on each resistance contact, so that it may not be moved until the current has reached a predetermined limit. A solenoid is arranged in the circuit, and its core is connected with a pawl engaging a ratchet-wheel on the spindle of the switch. On starting the motor, the current pulls in the core and causes a wheel to be locked until the current falls below the limit, when the switch can be turned to cut out one section of the resistance, and so on. Means are provided for short-cuiting the coil in cases of emergency. The reversing switch may be fitted with an extra contact which short circuits the solenoid, or a special switch fitted with a tell-tale may also be fitted. In arrangements with two motors, the solenoid is so connected as to be in series with one and in parallel with the other when the motors are working in parallel. 6 claims.

21,467. "An improved form of alternating current transformer." Veritys, Limited, and L. J. Steele. Dated October 12th, 1898. The laminated cores and yokes are separable and are clamped by end pieces connected together by tie-rods. The top end piece is grooved for the reception of the edge of the metallic casing so as to be watertight, and on the front is fitted a board for the terminals, &c. The transformer preferably has a single-winding tapped at the required points. 2 claims.

21,524. "Improvements in electro-magnetic variable speed and clutch-gearing." H. A. Wollaston and R. Kennedy. Dated October 13th, 1898. Motion is transmitted from the shaft to the pulley by means of an alternating current generator having a short-circuited armature and a separately-excited field magnet. The armature consists of a soft iron or other ring and a copper or other suitable hoop secured upon a disc filled to the pulley. The field magnet has the poles of any one side of similar polarity. The armature is rotated at a speed less than that of the field magnet, the difference depending upon the load on the pulley and upon the strength of the field magnet which may be varied by means of the rheostat. 4 claims.

21,550. "Improvements in systems of control for electric motors and railway trains." W. P. Potter. Dated October 13th, 1898. (Date claimed under Act, March 17th, 1898.) Relates to master controller arrangements for the motor and brake controllers on electrically-propelled trains, whereby the latter are synchronously actuated. For this purpose the subsidiary controllers are driven by electromotors, and their motion is limited by stops which are successively withdrawn as the master controller is turned. Springs or other means return the controllers to the off or braking position. The general arrangement of the connections and the construction of the switches are shown in the specification and are too complicated for purposes of abridgment. 25 claims.

21,551. "Improvements in controlling electric motors and electrically-propelled railway trains." E. W. Rice, jun. Dated October 13th, 1898. (Date claimed under Act, March 26th, 1898.) Relates to master controller arrangements for the motor controllers on electrically-propelled trains whereby the latter are positively actuated in both directions by a pilot motor which is supplied with current by the propelling motors acting as generators when the main current fails. All the collectors on the train are connected to a common wire to obviate temporary loss of current at any one of them. The general arrangement of the connections is shown in the specification and are too complicated for purposes of abridgment. 22 claims.

21,633. "Improvements in electricity meters." G. Hookham. Dated October 14th, 1898. Relates to energy meters. A clock drives a ratchet wheel, an escapement anchor with a fork and a pendulum carrying a shunt coil within a stationary main current coil by which its rate is varied. The fork is linked to a double pawl on a support, loose on a shaft. The pawl is held down at either side by a tumbling or spring-actuated lever, to drive either of two oppositely-toothed ratchet wheels fixed on the shaft, which is geared to a counter. The pawl and lever are turned periodically by a uniformly driven cam lifting or dropping a lever so that shoulders on this engage pins on the lever alternately. The shaft and counter are thus driven oppositely during successive periods, and if no energy is being supplied the counter is returned to zero at the end of alternate periods. The lever carries an insulator with four contact plates connected in opposite pairs to the coil and making contact with corresponding plates on the pawl, these being connected in opposite pairs to the supply conductors. The current in the coil is thus reversed at each reversal of position of the pawl and lever, so that the main current causes the pendulum to oscillate more rapidly while the counter is being driven forward, and more slowly while it is being driven backward, during the succeeding period. Instead of reversing the current in the coil, the contact maker may be arranged to supply current to it in alternate periods only, the pendulum swinging at its natural rate in the intervening periods. Friction pawls and ratchets may be used instead of the toothed gear. The meter may be used to measure quantity by supplying the coil at constant pressure. 3 claims.

21,638. "Improvements in arc lamps for projection and for laboratory or like purposes." J. Stuart and J. H. Barton. Dated October 14th, 1898. Relates to arc lamps regulated by hand for projection and like purposes. A support of channel section is pivoted at its lower end to a foot piece, and is secured adjustably by a clamping screw inserted through a slotted plate. The support carries a slider retained by screws passed through slots, and adjustable up and down by a rack engaging a pinion on a shaft carried by the support, and rotatable by a milled head. The slider has arms carrying a double-threaded screw rotatable by a milled head, and supporting two sliders which are guided by one edge of the support. The upper slider carries a slotted plate held by a screw and adjustable by a screw set in the slider, and having a collar in engagement with a slot in the plate. The plate and the lower slider extend forward at one side of the support to carry the carbon holders and binding screws, insulating plates being interposed. The foot piece may be laterally movable as described in Specification No. 30,247, A.D. 1897. 2 claims.

21,665. "A resistance measurer." C. W. S. Crawley. Dated October 14th, 1898. Relates to resistance meters. A specially graduated current meter is connected in series with a voltaic cell of constant electromotive force and high resistances, which are adjusted to give the maximum indication on the meter. The resistance to be measured is then connected as a shunt to the meter, reducing the deflection. The meter is graduated by use of known resistances, so that the resistance of the shunt is directly indicated. In a modified arrangement the resistance to be measured is placed in series with the meter resistances and cell, and a fixed shunt is connected across the resistance and meter. 2 claims.